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ABSTRACT

This set of job and task sheets consists of three multi-part jobs that are adaptable for use in regular vocational industrial education programs for training machinists and machine shop operators. After completing the sheets included in this volume, students should be able to construct a planer jack, a radius cutter, and a surface gage. Each job sheet contains a title, list of necessary materials, list of required tools and equipment, general instructions, a detailed list of procedures and tasks, and check points. Included on the task sheets are a task title, a list of tools and materials needed to complete the task, and a task breakdown that outlines the steps necessary for completing the task as well as key points pertaining to their execution. (MN)

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A

SUGGESTED SET OF JOB AND TASK SHEETS

FOR

MACHINE SHOP TRAINING

PRINTED 1977

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FOREWORD

The job and task sheets included in this series are an advanced continuation of Part I and Part II. This series is adaptable for use in the regular vocational industrial education programs for the training of machinists and machine shop machine operators.

In the planning of this series of advanced job and task sheets a concerted effort has been made to include those articles that are useful, as well as excellent learning experiences. This will have the results of not only conserving materials but will stimulate the interest of learners at their work.

Suggestions are included for teachers which may be of help in making the best use of the job and task sheet series.

Part III consists of three advanced multi-part jobs. Each job is accompanied by task sheets. The job and task sheets are broken down into steps and key points for ease of carrying the learner through the job step by step. Each job will contain special instructions as to the specific procedure to follow in the task to be performed. Since each job is different in the method of constructing, it is important that the student read and understand these instructions.

I. USE OF THE JOB SHEET SERIES

In compiling the jobs for this series, all essential details of production procedures necessary to train an operator for a special unit skill occupation have been considered and included as far as possible. It will, however, be necessary for the instructor to analyze each job as assignments are made to learners and check to be sure that all information necessary for instruction is included on the job and task sheets.

If the details on the job and task sheets do not wholly meet the needs of the learner, it will be necessary for the instructor to expand or modify the information to conform to the situation at hand. After desirable modifications have been made, it is expected that the instructor will arrange for the reproduction of a sufficient number of sheets to accommodate the learners.

In helping the learners with new experiences, instruction supplementary to the information given on the job and task sheets should always be in order. This may take the form of a shop demonstration, a shop talk, working with the individual learner, or referring the learner to suitable reference materials. Safe methods of working in connection with the assigned jobs must always be emphasized.

It will be noted that all of the projects require more than one part for completion. This being the case, job sheets will be written for each new part. Whereas, in Parts I and II, task sheets were written for each task, tasks will now be treated as steps within the task of constructing a part. The student should be able to function properly in this manner. In some jobs, special instructions will be given concerning routing of the job and methods by which the learner is to use the task sheets. In all cases, the training requires that the job be routed from one training station to another in proper sequence. The intent here is to approximate the production plan in industry and assure effective training for the learner in a unit skill operation.

Many opportunities have been built into the jobs to afford the learner the occasion to become experienced in making judgements and decisions concerning procedures, processes, and calculations. Some tasks require the designing and constructing of special tooling, thereby adding to the experience of the learner.

It should be noted that in the use of job and task sheets the learner is given the drawing, job sheet, and task sheet to assist and guide in performing the task. (It is suggested that each learner performing a specific job be given a complete set of job and task sheets.) Where possible, the job and task sheets should be laminated in plastic or inserted in plastic folders to protect against damages caused by handling. This permits use of job and task sheets over again.

Use of Tolerances

The tolerances specified on the drawings in this series are made to conform to standard industrial practice as nearly as possible. These tolerances should be adhered to as nearly as shop conditions will allow; otherwise, the training will not completely serve its purpose. The ability of the student to hold specified tolerances is essential to qualify for employment in the skilled occupation.

Variation in Machine Equipment

The proper sequence on machines or type of task necessary for the completion of each job has been noted on the job sheets. The sequence may be changed whenever necessary to meet shop conditions. In many cases the task may be done with either of two types of machines such as a milling machine or a shaper. In this case the two tasks are detailed on separate task sheets. This is done because of the known limitations of equipment in some shops and also to emphasize the fact that there are often more ways than one to perform a task.

Limitations in Using Job and Task Sheets

The instructor should bear in mind at all times that instruction sheets do not include technical information involved in processing. The demonstration, shop talks, working with learners on the job, or referring learners to specific printed materials are always essential supplementary teaching methods that must be used. Additional necessary related information and instruction, such as reading blueprints and making calculations, should be taught as the learners progress through the jobs. Shop reference books and pamphlets should always be at hand in the shop library, and this printed material should be used as needed and required by the learners to obtain information on all aspects of the occupation.

The job and task sheets of this series are set up as suggestions only. It is the instructor's privilege to modify job and task sheets to meet the conditions existing in the shop. At times it will be essential to change information or procedures outlined on the job and task sheets. In this case additional job and task sheets should be provided to meet specific training needs and to include additional jobs.

This job sheet series does not include all the tasks that can be performed on the machines listed. In case training requirements call for other tasks than those found in the Chart of Tasks, the instructor will find it necessary to find other jobs provided to meet specific training needs and to include additional jobs.

The instructor should bear in mind that although it is recommended the learner follow the job and task sheets in the order they are written, the instructor may deviate from the sequence in order to meet the needs of the student or shop situation. (Should deviations be necessary, the instructor should make available to the learner those previous job and task sheets the learner has not completed to use as references.)

II. USE OF THE DRAWINGS

The drawings provided in connection with each job are working drawings made to conform as closely as possible to industrial standards. The drawings are printed on tracing paper so as to make possible their reproduction in blueprint form by the local schools. It is expected that the learner will become familiar with the reading of blueprints so that the finished product of a job may be visualized and an understanding created of the tasks involved in the job. Instruction in blueprint reading, interpreting specifications, and making necessary calculations must be given with each job.

III. USE OF REFERENCES

The use of references, in any form that will be helpful to the learner, will be an aid to the instructor in successful teaching. The instructor should have available for the learner at all times reference material which will assist the learner in obtaining additional information related to the job on which work is being done.

IV. ANALYSIS OF TASKS

The following chart, Chart for Prints and Job Sheets, lists items to be made, print numbers, and types of tasks involved in the processing. This chart should prove helpful to the instructor in making learner assignments. The chart can be used in connection with a progress chart to check the coverage of the learners' progress through the course. (The jobs covering types of tasks such as bench work, drill press work, etc. are in the learning order, simple to the complex, insofar as possible. The order in which the different types of tasks occur on the chart for a given article does not necessarily represent the order in which the tasks are performed in production.)

CODING OF JOB AND TASK SHEETS

As a means of organizing and arranging the job and task sheets in a sequential order for use and reference, the following coding system is used:

1. Each machine operation, as related to the course outline, is expressed as a unit of instruction and is designated by a roman numeral.
   Example: The unit of instruction, Engine Lathe, is designated by VII.
2. Each job in which the machine or unit of instruction is used is designated by a capital letter.
   Example: The third job in which the Engine Lathe is used would be designated VII-C, that is, VII for unit of instruction and C for the third job in which the Engine Lathe is used.
3. Each task within a job is designated by a number where there is only one task, or a number and a lower case letter where there is more than one task.
   Example: The first task of the third job in which the Engine Lathe is used would be designated VII-C-1; and the second task would be designated VII-C-1a.
4. On jobs containing multiple parts where the machine or unit of instruction is used to construct more than one part within the job, the task number would change to the next number from the previous one.
   Example: The second task of the second part of the third job in which Engine Lathe is used would be designated VII-C-2a.
5. Each job sheet is designated by (J) and entitled and coded to each job with which it is used.
   Example: VII-C-2(J)
6. Each task sheet is designated by (TS), and entitled and coded to each task to be used in the performance of using that unit of instruction or machine.
   Example: VII-C-2a(TS)

UNITS OF INSTRUCTION

The units of instruction or those machines or operational procedures used in performing a job, as related to the course outline, are as follows:

I. Orientation
II. Measuring
III. Blueprint reading
IV. Bench
V. Power Saw
VI. Drill Press
VII. Lathe
VIII. Shaper
IX. Milling Machine
X. Grinders
XI. Heat Treatment
XII. Machine Maintenance

LIST OF REFERENCES

REF. #1. WALKER, JOHN R., MODERN METALWORKING, GOODHEART-WILLCOX, 123 W. TAFT DRIVE, SOUTH HOLLAND, IL 60474, 1970, 520 PAGES

REF. #2. LUDWIG, OSWALD A., METALWORK TECHNOLOGY AND PRACTICE, MCKNIGHT AND MCKNIGHT PUBLISHING COMPANY, BLOOMINGTON, IL, 61701, 1969, 630 PAGES

REF. #3. WALKER, JOHN R., MACHINING FUNDAMENTALS, GOODHEART-WILLCOX, 123 W. TAFT DRIVE, SOUTH HOLLAND, IL 60474, 1969, 512 PAGES

REF. #4. MCCARTHY, WILLARD J. AND SMITH, ROBERT E., MACHINE TOOL TECHNOLOGY, MCKNIGHT AND MCKNIGHT PUBLISHING COMPANY, BLOOMINGTON, IL 61701, 1969, 672 PAGES

REF. #5. KRAR, S. F., OSWALD, J. W., AND ST. AMAND, J. E., TECHNOLOGY OF MACHINE TOOLS, MCGRAW-HILL COMPANY OF CANADA LIMITED, TORONTO, CANADA, 1969, 528 PAGES

REF. #6. ANDERSON, JAMES AND TATRO, EARL E., SHOP THEORY, MCGRAW-HILL COMPANY, DALLAS, TEXAS, 1974, 568 PAGES

REF. #7. PORTER, HAROLD W., LASCOE, ORVILLE D., AND NELSON, CLYDE A., MACHINE SHOP OPERATIONS AND SETUPS, AMERICAN TECHNICAL SOCIETY, CHICAGO, 60637, 582 PAGES

TABLE OF CONTENT

JOB/TASK NUMBER	JOB/TASK SHEET TITLES	PAGE NUMBER
	PLANER JACK	1
VII-A-1(J)	Job Sheet on Engine Lathe	7
VII-A-1b(TS)	Drill and Turn 13°45' Taper on End Cap	11
VII-A-2c(TS)	Set Up and Turn Groove	13
VII-A-2d(TS)	Set Up and Turn Two 1/16" Chamfers	15
VII-A-2e(TS)	Set Up and Cut 1/2" - 20 N. F. Threads	17
VII-A-2g(TS)	Set Up Machine and Neck Workpiece	19
VII-A-2h(TS)	Set Up Machine, Turn Ball, and Chamfer	21
VII-A-3a(TS)	Set Up Machine and Turn Point on Head	23
VII-A-4b(TS)	Lay Out Workpiece for Turning 3/4" Diameter	25
VII-A-4d(TS)	Turn 3/4" Diameter to Layout Lines	27
VII-A-4e(TS)	Lay Out 3/4" Diameter for 3/8" Wide Knurl	29
VII-A-4i (TS)	Set Up and Counterbore Workpiece	31
VII-A-4j (TS)	Set Up to Bore 15° Angle	33
VII-A-4k(TS)	Bore 15° Angle	35
VII-A-4m(TS)	Cut Off Workpiece 1 9/16" Long	37
VII-A-6e(TS)	Set Up Cut Off Tool and Turn Diameter	39
IX-A-1(J)	Job Sheet on Horizontal Milling Machine	41
IX-A-1b(TS)	Set Up Vise on 45° Angle	43
IX-A-1c(TS)	Set Up Part #1 in Vise	45
IX-A-1d(TS)	Set Up Machine and Cut 90° "V"	47
IX-A-2d(TS)	Set Up Vise at 30° Angle	49
IX-A-2g(TS)	Set Up Vise at 60° Angle	51
VI-A-1(J)	Job Sheet on Drill Press	53
VII-A-8(TS)	Set Up and Form Cap on Ball	55
IV-A-1(J)	Job Sheet on Bench	57
IV-A-1(TS)	Tap Hole	59

	RADIUS CUTTER	61
IV-B-1(J)	Job Sheet on Bench	71
IV-B-1a(TS)	Lay Out Radii and Holes	73
V-A-1(J)	Job Sheet on Band Saw	77
V-A-1b(TS)	Saw 3/4" Radius	79
X-A-1(J)	Job Sheet on Grinder	81
X-A-1a(TS)	Grind 3/4" Radius	83
VII-B-1(J)	Job Sheet on Engine Lathe	85
VII-B-1(TS)	Set Up and True Workpiece	87
VII-B-1a(TS)	Drill and Tap Hole	91
VII-B-1b(TS)	Turn Radii: 7/8" and 1 1/2"	93
VIII-A-1(J)	Job Sheet on Shaper	95
VIII-A-1a(TS)	Machine Offsets on Shank	97
IX-B-1(J)	Job Sheet Horizontal Milling Machine	101
IX-B-1(TS)	Machine Offsets on Shank	103
VI-B-1(J)	Job Sheet on Drill Press	107
VI-B-1(TS)	Lay Out, Drill and Ream 3/8" Hole	109
VII-B-2(J)	Job Sheet on Engine Lathe	113
VII-B-2(TS)	Machine Worm Screw	115
VII-B-3(J)	Job Sheet on Engine Lathe	119
VII-B-3(TS)	Machine Swivel Screw	121
IX-B-2(J)	Job Sheet on Milling Machine	125
IX-B-2(TS)	Set Up and Mill 1/16" X 1/16" Slot	127
IV-B-2(J)	Job Sheet on Bench	129
IV-B-2(TS)	Lay Out Center for 3/8" Reamed Hole	131
VII-B-4(J)	Job Sheet on Engine Lathe	133
VII-B-4(TS)	Rough Turn Base of Tool Holder, Drill and Ream 3/8" Hole	135
IX-B-3(J)	Job Sheet on Vertical Milling Machine	137
IX-B-3(TS)	Set Up and Mill 3/4" Spherical Radius	139
IX-B-3a(TS)	Set Up and Mill 1/2" Spherical Radius	141

IX-B-3b(TS)	Set Up and Mill Tool Holder to Finish Height	143
IV-B-2a(TS)	Lay Out Center for Tapred Hole and Square Hole	145
VI-B-2(J)	Job Sheet on Drill Press	147
VI-B-2(TS)	Set Up and Drill 1/4" Hole Through	149
VI-B-2a(TS)	Drill #7 Hole	151
VI-B-2b(TS)	Set Up and Counterbore 9/16" Hole	153
X-B-1(J)	Job Sheet on Grinder	155
X-B-1b(TS)	Grind Special Broach	157
IV-B-2b(TS)	Set Up and Broach 1/4" Square Hole	159
VII-B-4a(TS)	Finish Turn Tool Holder Base to 1 11/16" Diameter	161
VII-B-4b(TS)	Turn 1/4" X 7/16" Diameter	163
VII-B-4c(TS)	Set Up and Turn 2.2375" Diameter	165
VI-B-3(J)	Job Sheet on Drill Press	167
VI-B-3(TS)	Construct Special Tool Post Fixture	169
VII-B-4d(TS)	Set Up Special Fixture and Mount Workpiece	171
VII-B-4e(TS)	Turn Hob	173
	SURFACE GAGE	175
VIII-B-1(J)	Job Sheet on Shaper	197
VIII-B-1a(TS)	Machine Base Square and to Size	199
IX-C-1(J)	Job Sheet on Horizontal Milling Machine	203
IX-C-1b(TS)	Machine Base Square and to Size	205
X-B-1(J)	Job Sheet on Surface Grinder	209
X-B-1a(TS)	Set Up, True Grinding Wheel, and Grind Workpiece to Finished Size	211
IV-C-1(J)	Job Sheet on Bench	215
IV-C-1(TS)	Lay Out Centers for Holes	217
IV-C-1a(TS)	Lay Out Grooves, Slots, and Angles	219
VI-C-1(J)	Job Sheet on Drill Press	223
VI-C-1(TS)	Set Up, Drill, Ream and Counter Drill All Holes	225

IV-C-2(J)	Job Sheet on Bench	229
IV-C-2a(TS)	Tap All Required Holes	231
IX-C-2(J)	Job Sheet on Milling Machine	233
IX-C-2(TS)	Mill 90^{o} Vee Groove with 1/8"^{R}	235
IX-C-2a(TS)	Mill 3/8" Radius Groove	237
IX-C-2b(TS)	Mill Vee Groove with 7/32"^{R}	239
IX-C-2c(TS)	Mill 10^{o}5' Angle on Top Face	241
IX-C-2d(TS)	Mill 1/4" Slot	245
X-B-2(J)	Job Sheet on Surface Grinder	247
X-B-2(TS)	Set Up, True Grinding Wheel and Grind 10^{o}5' Angles	249
X-B-3(J)	Job Sheet on Surface Grinder	251
X-B-3(TS)	Grind Workpiece to Specified Thickness	253
IV-C-3(J)	Job Sheet on Bench	255
IV-C-3(TS)	Completely Lay Out Rocker	257
VI-C-2(J)	Job Sheet on Drill Press	261
VI-C-2(TS)	Drill All Holes and Countersink Required Holes	263
VII-C-1(J)	Job Sheet on Engine Lathe	267
VII-C-1(TS)	Grind Special Tapered Counterbore	269
VI-C-2a(TS)	Counterbore 3/8" Hole With Special Tapered Counterbore	271
V-B-1(J)	Job Sheet on Band Saw	273
V-B-1(TS)	Band Saw Rocker	275
IV-C-4(J)	Job Sheet on Bench	277
IX-C-3(J)	Job Sheet on Horizontal Milling Machine	279
IX-C-3(TS)	Mill 7/32" Radius on Two Ends	281
IV-C-5(J)	Job Sheet on Bench	283
IV-C-5a(TS)	Lay Out Centers for Drilled Holes	285
VI-C-3(J)	Job Sheet on Drilled Press	287
VI-C-3(TS)	Drill, Ream, and Countersink Holes	289
IX-C-3a(TS)	Mill 1/32" Slot	293

VII-C-2(J)	Job Sheet on Engine Lathe	295
VII-C-2(TS)	Machine Shoulder Screw Part #23	297
VII-C-2a(TS)	Machine Shoulder Screw Part #8	301
IX-C-4(J)	Job Sheet on Vertical Milling Machine	303
IX-C-4(TS)	Drill and Ream Two Holes Perpendicular to Each Other	305
IX-C-4a(TS)	Mill Two Flats Parallel to Each Other	309
VII-C-3(J)	Job Sheet on Engine Lathe	311
VII-C-3(TS)	Machine Pressure Sleeve	313
IX-C-4(J)	Job Sheet on Vertical Milling Machine	317
IX-C-4(TS)	Drill and Ream Holes	319
VII-C-4(J)	Job Sheet on Engine Lathe	321
VII-C-4(TS)	Machine Pressure Cup	323
IX-C-5(J)	Job Sheet on Vertical Milling Machine	325
IX-C-5(TS)	Drill 9/64" Hole	327
VII-C-5(J)	Job Sheet on Engine Lathe	329
VII-C-5(TS)	Machine Two Pivot Screws	331
IX-C-6(J)	Job Sheet on Horizontal Milling Machine	335
IX-C-6(TS)	Mill 1/32" Slots in Pivot Screws "A" and "B"	337
VII-C-6(J)	Job Sheet on Engine Lathe	339
VII-C-6(TS)	Turn, Drill, and Counterbore Angular Washer	341
IX-C-7(J)	Job Sheet on Vertical Milling Machine	343
IX-C-7(TS)	Mill 3/16" X 5/16" Oblong Slot	345
VI-C-4(J)	Job Sheet on Drill Press	347
VI-C-4(TS)	Machine Special Broach Fixture	349
X-B-4(J)	Job Sheet on Grinder	351
X-B-4(TS)	Grind Special Broach	353
IV-C-6(J)	Job Sheet on Bench	355
IV-C-6a(TS)	Broach Slot	357
VII-C-7(J)	Job Sheet on Engine Lathe	359
VII-C-7(TS)	Machine Adjusting Screw - Part #19	361

VII-C-8(J)	Job Sheet on Engine Lathe	363
VII-C-8(TS)	Face Pins to Length	365
IX-C-8(J)	Job Sheet on Horizontal Milling Machine	367
IX-C-8(TS)	Mill Slots	369
VII-C-9(J)	Job Sheet on Engine Lathe	371
VII-C-9(TS)	Machine Pressure Nuts "A" and "B"	373
VII-C-10(J)	Job Sheet on Engine Lathe	377
VII-C-10(TS)	Machine Washers "A" - "B" - "C"	379
IX-C-9(J)	Job Sheet on Vertical Milling Machine	383
IX-C-9(TS)	Mill 13/64" X 17/64" Oblong Slot	385
VI-C-5(J)	Job Sheet on Drill Press	387
IX-B-4(J)	Job Sheet on Grinder	389
IV-C-7(J)	Job Sheet on Bench	391
VII-C-11(J)	Job Sheet on Engine Lathe	393
VII-C-11(TS)	Machine Part #2: Marker	395
IX-C-10(J)	Job Sheet on Horizontal Milling Machine	397
IX-C-10(TS)	Mill 1/32" X 1/16" Double Bevels	399
VII-C-12(J)	Job Sheet on Engine Lathe	403
VII-C-12(TS)	Machine Surface Gage Post	405
VII-C-13(J)	Job Sheet on Engine Lathe	409
VII-C-13(TS)	Machine Part #3: Scriber	411
IV-C-8(J)	Job Sheet on Bench	413
IV-C-8(TS)	Form 1/2" Radius Scriber Point	415
IV-C8a(TS)	Heat Treat and Polish Scriber Points	417

MACHINE SHOP — PART III
JOBS & TASKS

JOB AND PRINT NUMBER	MACHINE SHOP JOB	TASKS							
		BENCH	SAW	DRILL PRESS	SHAPER	MILLING MACHINE	ENGINE LATHE	SURFACE GRINDER	TOOL GRINDER
1.	PLANER JACK	1	1	1		1	1		
2.	RADIUS CUTTER	2	2	2	1	2	2		1
3.	SURFACE GAGE	3	3	3	2	3	3		2

NAME ____________________

PROGRESS CHART

MACHINE SHOP – PART III

TASKS JOB PLANER JACK	SAW			BENCH							DRILL					SHAPER			MILLING MACHINE									ENGINE LATHE																							SURF GR.				TOOL GR		
	VERTICAL BAND SAWING (ST.)	VERTICAL BAND SAWING (RADII)	HORIZONTAL SAWING (STRAIGHT)	PREPARE SURFACE FOR LAYOUT	LAYOUT	BEND AND FORM	BROACH	TAP	HEAT TREAT	ASSEMBLE	DRILL TO LAYOUT	COUNTERBORE	COUNTERSINK	REAM	TAP	HORIZONTAL SHAPING	ANGLE SHAPING	FORM SHAPING	END MILLING	FACE MILLING	FORM MILLING	DRILLING	REAMING	INDEXING	SLITTING	SLOTTING	ANGLE MILLING	MOUNT WORK IN CHUCK	MOUNT WORK BETWEEN CENTERS	FACE	CENTER DRILL	TURN	TURN SHOULDER	TURN TAPER W/COMPOUND REST	TURN TAPER W/TAPER ATTACH.	DRILL	REAM	BORE	COUNTERBORE	GROOVE AND NECK	TURN RADII	COUNTERSINK	FORM	KNURL	CUT THREADS	HOB GEAR	CUT OFF	TAP	FILE	TAPER BORE	DRESS AND TRUE WHEEL	GRIND PLAIN SURFACE	GRIND ANGLE SURFACE	GRIND SLOT	DRESS AND TRUE WHEEL	GRIND TAPER	GRIND STRAIGHT SURFACE
PART #1 END CAP																																																									
PART #2 JACK SCREW																																																									
PART #3 JACK SCREW																																																									
PART #4 JACK SCREW STAND																																																									
PART #5 SPACER																																																									
PART #6 SPACER																																																									
PART #7 BASE																																																									

MACHINE SHOP PLANER JACK

ENGINE LATHE	1
HORIZONTAL MILLING MACHINE	1
LAYOUT AND DRILL PRESS	1
BENCH	1

AIM: THE STUDENT WILL BE ABLE TO SELECT MATERIAL, READ DRAWINGS, AND CONSTRUCT A PLANER JACK ACCORDING TO SPECIFICATIONS; USING TOOLS, EQUIPMENT, MACHINES, AND MATERIALS CALLED FOR IN THE JOB.

CHECKING STANDARDS

1. SELECTION OF TOOLS, EQUIPMENT, AND SUPPLIES.
2. SET UP AND PREPARE MACHINE FOR JOB.
3. LAYOUT ACCORDING TO SPECIFICATIONS AND DRAWING.
4. HOLD ALL DIMENSIONS TO PRINT SPECIFICATIONS.
5. HOLD ALL SURFACES TO PRECISION FINISH.
6. HOLD SURFACE FINISH TO STANDARDS OF CRAFTSMANSHIP.
7. MAINTAIN AN ATTITUDE OF APPRECIATION FOR WORK, MATERIALS, TOOLS, EQUIPMENT, MACHINES, AND STANDARDS.
8. MAINTAIN TOOLS, MACHINES, AND EQUIPMENT IN GOOD WORKING ORDER AND REPAIR.
9. MAINTAIN SAFE WORKING HABITS.

REFERENCES

REF. #1. WALKER, JOHN R., *MODERN METALWORKING*

REF. #2. LUDWIG, OSWALD A., *METALWORK TECHNOLOGY AND PRACTICE*

REF. #3. WALKER, JOHN R., *MACHINE FUNDAMENTALS*

REF. #4. MCCARTHY, WILLARD J. AND SMITH, ROBERT E., *MACHINE TOOL TECHNOLOGY*

REF. #5. KRAR, S. F., OSWALD, J.W., AND ST. AMAND, J. E., *TECHNOLOGY OF MACHINE TOOLS*

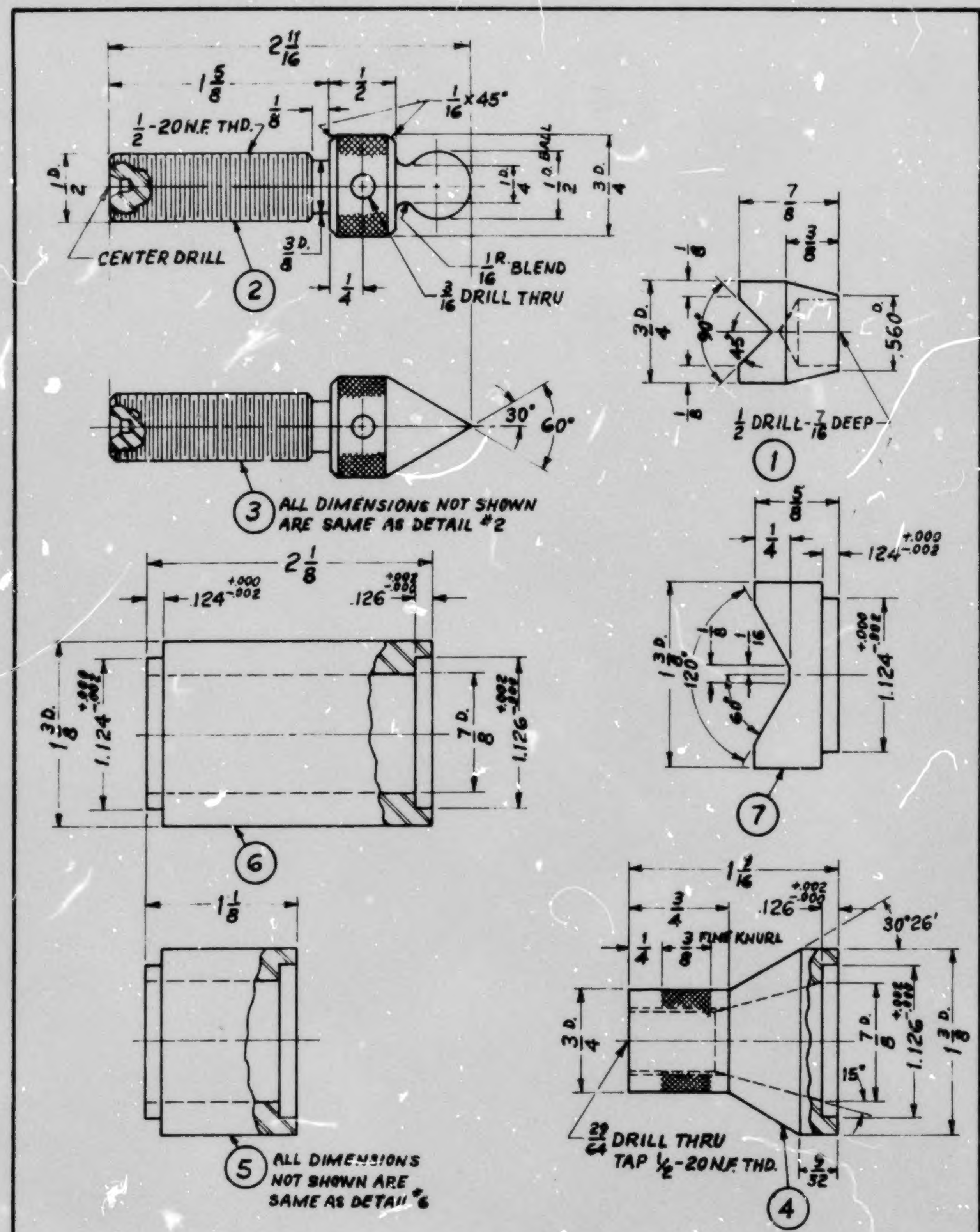
REF. #6. ANDERSON, JAMES AND TATRO, EARL E., *SHOP THEORY*

REF. #7. PORTER, HAROLD W., LASCOE, ORVILLE D., AND NELSON, CLYDE A., *MACHINE SHOP OPERATIONS*

NOTE: IN THIS JOB THE STUDENT IS TO GET ALL NECESSARY MATERIAL FROM MATERIAL SUPPLY PRIOR TO STARTING THE TASKS FOR CONSTRUCTION OF THIS MULTI-PART JOB. THE STUDENT IS CHARGED WITH KEEPING TRACK OF EACH AND ALL PARTS.

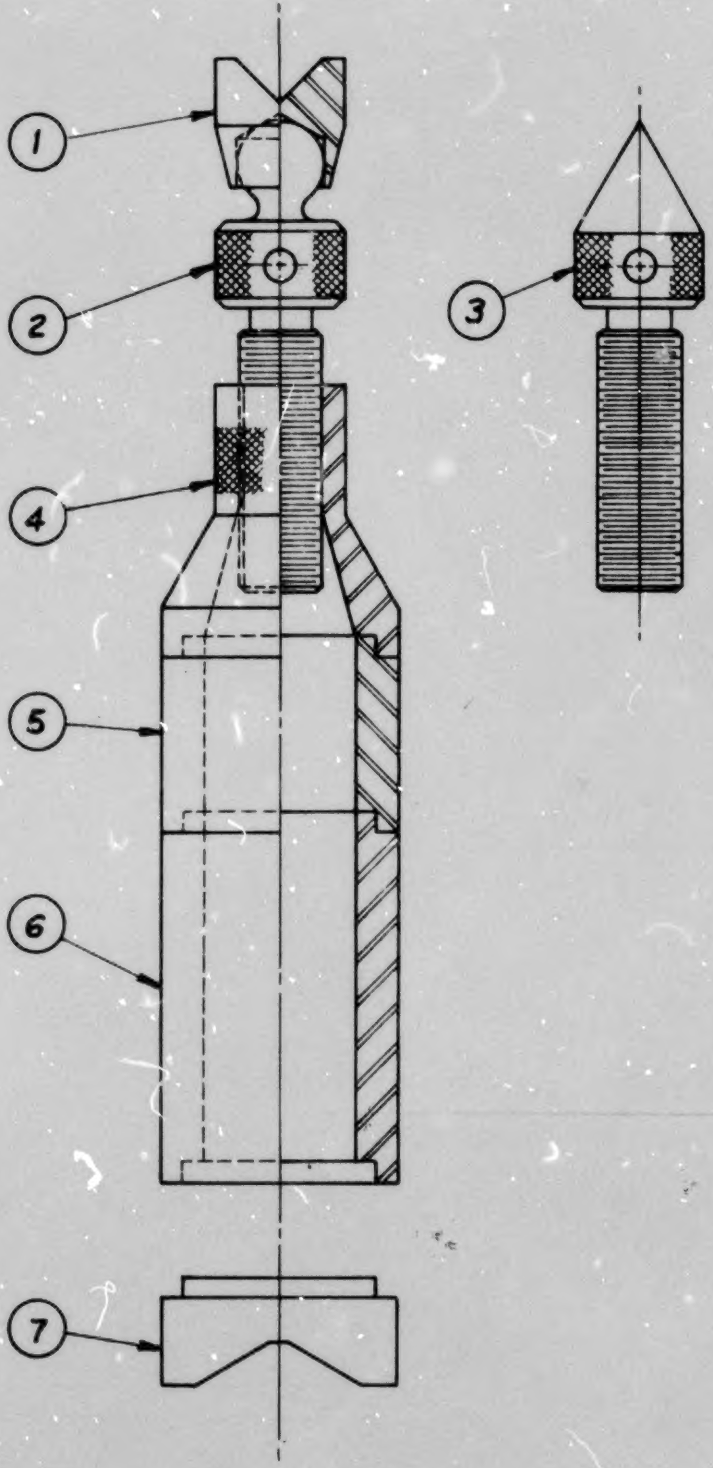
THE JOB AND TASK SHEETS ARE WRITTEN FOR THE COMPLETION OF ALL PARTS ON ONE MACHINE BEFORE PROCEEDING TO THE NEXT MACHINE, ETC.

AT THIS STAGE OF TRAINING NO REFERENCE WILL BE MADE TO THOSE TASKS THAT HAVE BEEN PERFORMED REPEATEDLY IN PARTS I AND II. ONLY THOSE TASKS REQUIRING SPECIAL OPERATIONS OR SETUPS WILL BE WRITTEN. THE STUDENT WILL BE EXPECTED TO FUNCTION PROPERLY WITH THIS PROCEDURE.



2 11/16
1 5/8
1/2
1/16 × 45°
1/8
1/2-20 N.F. THD.
1/2 D.
1 D. BALL
1/4 D.
1/2
3/4 D.
3/8 D.
CENTER DRILL
1/4
1/16 R. BLEND
3/16 DRILL THRU
2
30°
60°
3 ALL DIMENSIONS NOT SHOWN ARE SAME AS DETAIL #2
7/8
3/8
1/8
3/4 D.
90°
45°
.560 D.
1/8
1/2 DRILL - 7/16 DEEP
1
2 1/8
.124 +.000 -.002
.126 +.002 -.000
1 3/8 D.
1.124 +.000 -.002
7/8 D.
1.126 +.002 -.000
6
5/8
1/4
.124 +.000 -.002
1 3/8
1/8
1/16
120°
60°
1.124 +.000 -.002
7
1 1/8
5 ALL DIMENSIONS NOT SHOWN ARE SAME AS DETAIL #6
1 9/16
3/4
.126 +.002 -.000
30°26'
1/4
3/8 FINE KNURL
3/4 D.
7/8 D.
1.126 +.002 -.000
1 3/8 D.
15°
29/64 DRILL THRU TAP 1/2-20 N.F. THD.
9/32
4

DRAWING NO. 1A	PLANER JACK DETAILS	TOLERANCE CHART
LATHE JOB NO. 1 MILLING JOB NO. 1 DRILL PRESS JOB NO. 1	MATERIAL: C.R. STEEL FINISH: SCALE: FULL SIZE	FRACTIONS ± 1/64 DECIMALS ±.005 ANGLES ± 1/2°



DRAWING NO. 1	PLANER JACK	TOLERANCE CHART
LATHE JOB NO. 1 MILL JOB NO. 1. DRILL PRESS JOB NO. 1	MATERIAL: C.R. STEEL FINISH : SCALE : FULL SIZE	FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES ± 1/2°

VII-A-1(J)

JOB SHEET
ON
ENGINE LATHE

JOB:	PLANER JACK	
MATERIALS:	PARTS #1, #2, #3, ONE PIECE COLD ROLLED STEEL 3/4" DIAMETER X 7" LONG, PARTS #4, #5, #6, #7, ONE PIECE COLD ROLLED STEEL 1 3/8" DIAMETER X 7" LONG, CUTTING OIL	
TOOLS AND EQUIPMENT:	ENGINE LATHE UNIVERSAL CHUCK, COLLET ATTACHMENT, 1/2" COLLET, FACING TOOLS, ROUND NOSE TURNING TOOL, STANDARD TURNING TOOL, THREADING TOOLS, CUT-OFF TOOL, LIVE CENTER, DRILL CHUCK AND KEY, SMALL CENTER DRILL, KNURLING TOOLS, CENTER GAUGE, 0-1" MICROMETER, 1-2" MICROMETER, 6" RULE, DEPTH MICROMETER, VERNIER CALIPER, 1/2" DRILL, 7/8" DRILL, BORING TOOLS, 10" MILL FILE, LAYOUT TOOLS, SCRIBE, OIL CAN	
GENERAL INSTRUCTIONS:	BEFORE BEGINNING THIS JOB READ REFERENCES: #1, PP. 36-1 TO 36-44, AND #2, PP. 462-494. STUDY JOB AND TASK SHEETS. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE	
PROCEDURE AND/OR TASKS:	OBTAIN MATERIAL FROM SUPPLY AND CUT TO LENGTH	
	VII-A-1(TS)	CHECK ENGINE LATHE FOR PROPER OPERATING CONDITION
PART #1	VII-A-1a(TS)	SET UP 3/4" DIAMETER MATERIAL AND FACE ONE END TO CLEAN UP
	*VII-A-1b(TS)	DRILL AND TURN 13° 45' TAPER ON END CAP
	VII-A-1c(TS)	CUT OFF WORKPIECE HOLD FOR MILL OPERATION
PART #2	VII-A-2(TS)	SET UP 3/4" STOCK IN LATHE 1. 3" PROTRUDING FROM END OF CHUCK JAWS 2. FACE 3. CENTERDRILL
	VII-A-2a(TS)	MOUNT LIVE CENTER IN WORKPIECE AND KNURL
	VII-A-2b(TS)	SET UP AND TURN 1/2" DIAMETER X 1 5/8" LENGTH
	*VII-A-2c(TS)	SET UP AND TURN GROOVE
	*VII-A-2d(TS)	SET UP AND TURN TWO 1/16" CHAMFERS
	*VII-A-2e(TS)	SET UP AND CUT 1/2" - 20 N. F. THREADS
	VII-A-2f(TS)	SET UP CUT-OFF TOOL 1. CUT OFF PART #2 TO 2 11/16" LONG 2. HOLD FOR FINISH LATHE OPERATION

PART #3	VII-A-3(TS)	SET UP AND MACHINE PART #3 1. SAME AS PART #2 2. TASKS a THROUGH f
PART #2	*VII-A-2g(TS)	SET UP MACHINE AND NECK WORKPIECE
	*VII-A-2h(TS)	SET UP MACHINE, TURN BALL, AND CHAMFER
PART #3	*VII-A-3a(TS)	SET UP MACHINE AND TURN POINT ON HEAD
PART #4	VII-A-4(TS)	SET UP 1 3/8" MATERIAL, 2" PROTRUDING FROM CHUCK JAWS
	VII-A-4a(TS)	FACE AND CENTER DRILL WORKPIECE
	*VII-A-4b(TS)	LAY OUT WORKPIECE FOR TURNING 3/4" DIAMETER
	VII-A-4c(TS)	SET UP LIVE CENTER
	*VII-A-4d(TS)	TURN 3/4" DIAMETER TO LAYOUT LINES
	*VII-A-4e(TS)	LAY OUT 3/4" DIAMETER FOR 3/8" WIDE KNURL
	VII-A-4f(TS)	KNURL 3/4" DIAMETER 1. KNURL AS BEFORE 2. KNURL TO BE 3/8" WIDE 3. KNURL BETWEEN LAYOUT LINES
	VII-A-4g(TS)	SET UP AND TURN 30° 26' OUTSIDE ANGLE WITH COMPOUND REST
	VII-A-4h(TS)	DRILL 29/64" DIAMETER X 2" DEEP HOLE IN END OF WORKPIECE
	*VII-A-4i(TS)	SET UP AND COUNTERBORE WORKPIECE
	*VII-A-4j(TS)	SET UP TO BORE 15° ANGLE
	*VII-A-4k(TS)	BORE 15° ANGLE
	VII-A-4l(TS)	SET UP CUT-OFF TOOL
	*VII-A-4m(TS)	CUT OFF WORKPIECE 1 9/16" LONG
PART #5	VII-A-5(TS)	SET UP WORKPIECE WITH 2" PROTRUDING FROM CHUCK JAWS
	VII-A-5a(TS)	SET UP AND DRILL 7/8" DIAMETER X 1 3/8" DEEP HOLE
	VII-A-5b(TS)	FACE END TO CLEAN UP
	VII-A-5c(TS)	COUNTERBORE 1.126" DIAMETER X .126" DEEP
		NOTE: MAINTAIN CLOSE TOLERANCE. REFER TO DRAWING
	VII-A-5d(TS)	LAY OUT OUTSIDE DIAMETER 1" FROM END
	VII-A-5e(TS)	SET UP CUT-OFF TOOL, TURN 1.124" DIAMETER X .124" WIDE
	VII-A-5f(TS)	CUT OFF WORKPIECE 1. HOLD 1 1/8" OVERALL LENGTH 2. HOLD .124" SHOULDER LENGTH

PART #6	VII-A-6(TS)	SET UP WORKPIECE 2 1/2" PROTRUDING FROM CHUCK JAWS
	VII-A-6a(TS)	SET UP AND DRILL 7/8" DIAMETER X 2 3/8" DEEP HOLE
	VII-A-6b(TS)	FACE END TO CLEAN UP
	VII-A-6c(TS)	COUNTERBORE 1.126" DIAMETER X .126" DEEP
	VII-A-6d(TS)	LAY OUT OUTSIDE DIAMETER 2" FROM END
	*VII-A-6e(TS)	SET UP CUT-OFF TOOL, TURN DIMENSIONS 1. MAINTAIN CLOSE TOLERANCE 2. REFER TO DRAWING
	VII-A-6f(TS)	CUT OFF WORKPIECE 1. HOLD 2 1/8" OVERALL LENGTH 2. HOLD .124" SHOULDER LENGTH
PART #7	VII-A-7(TS)	SET UP WORKPIECE WITH 1" PROTRUDING FROM CHUCK JAWS
	VII-A-7a(TS)	FACE END TO CLEAN UP 1. POINT OF DRILL HOLD FROM PART #6 NEED NOT BE FACED OFF IF IT IS LESS THAN 1/4" DEEP 2. 1/4" IS THE DEPTH OF 120° ANGLE
	VII-A-7b(TS)	LAY OUT OUTSIDE DIAMETER 1/2" FROM END
	VII-A-7c(TS)	SET UP CUT-OFF TOOL, TURN 1.124" DIMENSIONS X .124" WIDE DIAMETER 1. MAINTAIN CLOSE TOLERANCE 2. REFER TO DRAWING
	VII-A-7d(TS)	CUT OFF WORKPIECE 1. HOLD 5/8" OVERALL LENGTH 2. HOLD .124" SHOULDER LENGTH
	VII-A-7e(TS)	CLEAN MACHINE AND WORK STATION HOLD FOR MILL OPERATION
	VII-A-8(TS)	SET UP AND FORM CAP ON BALL

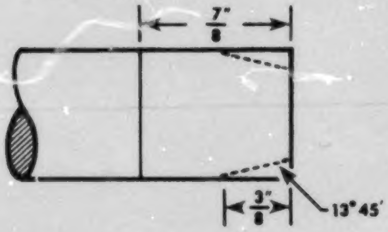
CHECKPOINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEDING WITH TASK.

1. CHECK MACHINE FOR PROPER OPERATING CONDITION.
2. CHECK MACHINE FOR SAFE AND CORRECT SETUP.
3. ALL DIMENSIONS HELD TO DRAWING SPECIFICATIONS.

*TASK SHEETS ACCOMPANY JOB SHEET

TASK:	DRILL AND TURN 13° 45' TAPER ON END CAP
JOB:	PLANER JACK
TRADE:	MACHINIST
TOOLS AND MATERIALS:	ENGINE LATHE, UNIVERSAL CHUCK, TURNING TOOL, TAILSTOCK DRILL CHUCK AND KEY, #1 CENTER DRILL, 1/2" DRILL, 6" RULE, VERNIER CALIPER, 0.1" MICROMETER, ROUND FILE, MILL FILE, 3/4" DIAMETER X 7" COLD ROLLED STEEL, CHUCK AND FACED

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP AND DRILL 1/2" HOLE	1. SET UP TAILSTOCK DRILL CHUCK 2. CENTER DRILL FOR PILOT HOLE 3. DRILL 1/2" HOLE NOTE: HOLD 7/16" DEPTH 4. REMOVE DRILL AND DRILL CHUCK 5. DEBURR WITH ROUND FILE OR SCRAPER
2. LAYOUT LENGTH OF 13° 45" TAPER  	1. MEASURE 3/8" FROM END OF WORKPIECE 2. SCRIBE 3/8" REFERENCE LINE NOTE: THIS IS WHERE TAPER WILL TAPER OUT
3. SET UP TOOLING	1. POSITION THE TURNING TOOL IN TOOL HOLDER 2. POSITION TOOL HOLDER IN TOOL POST 3. SET TOOL IN POSITION TO WORKPIECE FOR TURNING TAPER
4. SET COMPOUND REST	1. LOOSEN COMPOUND REST LOCK SCREWS 2. SET COMPOUND REST AT 13° 45' NOTE: POSITION THE COMPOUND REST KNOB AWAY FROM WORKPIECE 3. LOCK COMPOUND REST
5. SET MACHINE	1. REFER TO REF. #1, PP. 36-14 OR REF. #2, PP. 465-466

STEPS	KEY POINTS
	2. SET R.P.M. TO SPECIFICATIONS FOR TURNING
6. TURN TAPER	1. HAND FEED TOOL AWAY FROM 3/8" REFERENCE LINE TOWARD END 2. HOLD 3/8" LENGTH 3. HOLD .560 DIAMETER ON END NOTE: DIAMETER WILL BE HELD IF ANGLE SET UP AND LENGTH ARE CORRECT
7. DEBURR	BREAK ALL EDGES AND BURRS WITH FILE

SKETCHES: DRAWING #1A, PART #1, PLANER JACK

REFERENCES: REF. #1, PP. 36-24 TO 36-35
REF. #2, PP. 483-484

TASK:	SET UP AND TURN GROOVE
JOB:	PLANER JACK
TRADE:	MACHINIST
TOOLS AND MATERIALS:	ENGINE LATHE, UNIVERSAL CHUCK, CUT-OFF TOOL, VERNIER CALIPER, 10" MILL FILE, 6" RULE, WORK PIECE

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP TOOL	NOTE: CUT-OFF TOOL USED TO TURN GROOVE 1. CHECK TOOL FOR SHARPNESS 2. POSITION TOOL IN HOLDER AND TIGHTEN 3. SET UP HOLDER IN POST AND TIGHTEN
2. POSITION TOOL	1. POSITION TOOL TO HOLD 1 5/8" LENGTH, SEE DRAWING 2. LOCK CARRIAGE 3. TOOL PERPENDICULAR TO AND CENTERED ON WORK PIECE
3. TURN RELIEF	1. TURN MACHINE ON 2. FEED TOOL INTO WORK PIECE 3. HOLD DIAMETER TO 3/8" 4. USE VERNIER CALIPER TO CHECK DIAMETER
4. DEBURR	USUAL PROCEDURE, USE MILL FILE

SKETCHES: DRAWING #1A, PART #2, PLANER JACK

REFERENCES: REF. #1, P. 34-24
REF. #2, P. 475

TASK SHEET VII-A-2d(TS)

TASK: SET UP AND TURN TWO 1/16" CHAMFERS

JOB: PLANER JACK

TRADE: MACHINIST

TOOLS AND MATERIALS: ENGINE LATHE, UNIVERSAL CHUCK, CUT-OFF TOOL, 10" MILL FILE, 6" RULE, WORK PIECE

TASK BREAKDOWN:

STEPS		KEY POINTS
1. SET COMPOUND REST		NOTE: FOR SMALL CHAMFERS MOST ANY CUTTING TOOL MAY BE USED
	1.	LOOSEN COMPOUND REST
	2.	POSITION COMPOUND REST ON 45°
	3.	TIGHTEN COMPOUND REST
2. TURN CHAMFERS	1.	REFER TO DRAWING
	2.	TURN MACHINE ON
	3.	HOLD TWO CHAMFERS TO 1/16" WIDTH
	4.	TURN TWO 45° CHAMFERS
3. DEBURR		USUAL PROCEDURE

SKETCHES: DRAWING #1A, PART #2, PLANER JACK

REFERENCES: REF. #1, P. 36-28
REF. #2, P. 491

TASK SHEET

VII-A-2e (TS)

TASK: SET UP AND CUT 1/2" - 20 N. F. THREADS

JOB: PLANER JACK

TRADE: MACHINIST

TOOLS AND MATERIALS: ENGINE LATHE, UNIVERSAL CHUCK, LIVE CENTER, THREADING TOOL, THREE CORNER FILE, SCREW PITCH GAGE, CENTER GAGE

TASK BREAKDOWN:

STEPS	KEY POINTS
1. MOUNT WORKPIECE	1. LEAVE WORKPIECE IN CHUCK AS IN VII-A-2d(TS)
2. SET UP COMPOUND REST	1. SET THREADING TOOL IN TOOL HOLDER 2. PLACE TOOL HOLDER IN TOOL POST NOTE: LEAVE LOOSE 3. SET COMPOUND REST AT 29° TO THE RIGHT AND TIGHTEN
3. SET UP TOOL	1. SET THREADING TOOL PERPENDICULAR TO WORKPIECE. NOTE: USE CENTER GAGE. SEE REF. #1, PP. 36-30, 36-31 OR REF. #2, P. 489 2. POSITION TOOL ON CENTER LINE OF WORKPIECE
4. SET UP MACHINE	1. SET SPINDLE TO SLOW SPEED 2. SET THE GEAR BOX TO CUT TWENTY THREADS PER INCH 3. SET FEED CHANGE LEVER TO THREADING POSITION NOTE: LATHES WITH LEAD SCREW AND FEED ROD THE SAME 4. PUT ON SAFETY GLASSES
5. CUT 1/2" - 20 NF THREAD	1. TURN MACHINE ON 2. TURN CROSS SLIDE HANDLE UNTIL TOOL TOUCHES WORKPIECE 3. SET CROSS FEED DIAL TO "O" 4. SET COMPOUND REST DIAL ON "O"

STEPS		KEY POINTS
	5.	MOVE THE CARRIAGE TO THE RIGHT OF WORKPIECE UNTIL TOOL CLEARS WORKPIECE
	6.	TURN COMPOUND REST SLIDE IN .005"
	7.	ENGAGE HALF-NUT LEVER NOTE: ANY LINE ON CHASING DIAL MUST BE IN LINE WITH INDEX LINE ON OUTER RING
	8.	DISENGAGE HALF-NUT LEVER WHEN THE POINT OF TOOL REACHES THREAD RELIEF NOTE: TURN CROSS SLIDE HAND WHEEL COUNTERCLOCKWISE TO CLEAR TOOL FROM WORKPIECE
	9.	TURN CARRIAGE HANDWHEEL TO BRING TOOL BACK TO STARTING POSITION
	10.	TURN CROSS SLIDE IN TO ORIGINAL REFERENCE POSITION "O"
	11.	FEED COMPOUND REST IN .005"
	12.	REPEAT SAME PROCEDURE AS IN #7-#10 NOTE: IT WILL BE NECESSARY TO REDUCE DEPTH OF FUTURE CUTS TO .003" AND THEN .002"
	13.	FEED .001" ON FINAL TWO CUTS NOTE: THE LAST CUT WILL BE FED .001" IN ON CROSS SLIDE TO CLEAN UP THREAD
	14.	CUT THREAD TO DESIRED DEPTH
6. INSPECT AND BURR	1.	CHECK THREAD FOR CORRECT DEPTH
	2.	FILE THREAD CAREFULLY WITH THREE CORNER FILE
7. CUT OFF WORKPIECE	1.	CUT WORKPIECE OFF CAUTION: DO NOT LET WORKPIECE DROP CAUSING DAMAGE TO THREADS
	2.	BURR EDGES
		HOLD FOR NEXT TASK VII-A-2f(TS)

SKETCHES: DRAWING #1A, PART #2, PLANER JACK

REFERENCES: REF. #1, PP. 36-28 TO 36-33
REF. #2, PP. 488-491

TASK SHEET VII-A-2g(TS)

TASK: SET UP MACHINE AND NECK WORK PIECE

JOB: PLANER JACK

TRADE: MACHINIST

TOOLS AND MATERIALS: ENGINE LATHE, COLLET ATTACHMENT, 1/2" COLLET, CUT-OFF TOOL WITH SPHERICAL 1/16" RADII, 6" RULE, VERNIER CALIPER, WORK PIECE #2

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP COLLET	1. REMOVE CHUCK 2. INSTALL COLLET ATTACHMENT 3. SET UP 1/2" COLLET IN ATTACHMENT
2. SET UP CUTTING TOOL	1. INSTALL SPHERICAL 1/16" RADII CUT-OFF TOOL IN HOLDER 2. TIGHTEN CUT-OFF TOOL IN HOLDER 3. INSTALL HOLDER IN TOOL POST 4. POSITION TOOL POINT TO CENTERLINE OF WORK PIECE 5. POSITION TOOL PERPENDICULAR TO WORK PIECE 6. TIGHTEN TOOL POST
3. SET UP WORK PIECE #2	1. INSERT THREADED 1/2" DIAMETER END INTO COLLET TO SHOULDER 2. TIGHTEN COLLET
4. LAY OUT WORK PIECE	1. USE 6" RULE 2. MEASURE FROM END OF WORK PIECE TOWARD COLLET 9/16" 3. MARK WORK PIECE NOTE: THIS IS LENGTH OF BALL AND NECK
5. POSITION TOOL	1. POSITION TOOL CUTTING EDGE ON CENTERLINE OF WORK PIECE 2. ALIGN TOOL PERPENDICULAR TO WORK PIECE 3. POSITION LEFT SIDE OF CUT-OFF TOOL ON LAYOUT LINE 4. LOCK CARRIAGE

STEPS	KEY POINTS
6. TURN BALL NECK	1. TURN MACHINE ON 2. HAND FEED CUT-OFF TOOL IN SLOWLY 3. HOLD NECK DIAMETER TO 1/4" 4. CHECK DIAMETER WITH VERNIER CALIPER
7. DEBURR	USUAL METHOD

SKETCHES: DRAWING #1A, PART 2, PLANER JACK

REFERENCES: REF. #1, P. 36-24
REF. #2, P. 487

TASK SHEET

VII-A-2h (TS)

TASK:	SET UP MACHINE, TURN BALL, AND CHAMFER
JOB:	PLANER JACK
TRADE:	MACHINIST
TOOLS AND MATERIALS:	ENGINE LATHE, COLLET ATTACHMENT, 1/2" COLLET, 10" MILL FILE, ROUND NOSE TOOL, 0-1" MICROMETER, 6" RULE, WORK PIECE #2

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP TOOL	1. INSTALL ROUND NOSE TOOL HOLDER IN TOOL POST 2. POSITION POINT ON CENTERLINE OF WORK PIECE 3. POSITION TOOL PERPENDICULAR TO WORK PIECE 4. TIGHTEN TOOL POST
2. TURN BALL	NOTE: CHECK WITH INSTRUCTOR FOR ADDITIONAL INSTRUCTIONS AND DIRECTIONS 1. UNLOCK CARRIAGE 2. POSITION TOOL NEAR WORK PIECE 3. TURN MACHINE ON 4. TURN BALL BY FREE HAND METHOD a. OPERATE CARRIAGE WHEEL WITH LEFT HAND b. OPERATE CROSS SLIDE HANDWHEEL WITH RIGHT HAND NOTE: BOTH HANDWHEELS MUST BE OPERATED AT ONE AND THE SAME TIME TO TURN BALL 5. TURN BALL BY SIGHT
3. FILE BALL	1. FILE BALL TRUE AND SMOOTH BY SIGHT 2. BLEND BALL INTO 1/4" NECK NOTE: BALL WILL BE ROUGH AFTER TURNING WITH TOOL
4. CHAMFER	1. USE ROUND NOSE TOOL 2. TURN 1/16" X 45° CHAMFER ON BALL SIDE OF KNURLED HEAD

STEPS	KEY POINTS

HOLD FOR LAYOUT AND DRILL TASKS

SKETCHES: DRAWING #1A, PART #2, PLANER JACK

REFERENCES: CHECK WITH INSTRUCTOR

35

TASK SHEET

VII-A-3a(TS)

TASK: SET UP MACHINE AND TURN POINT ON HEAD

JOB: PLANER JACK

TRADE: MACHINIST

TOOLS AND MATERIALS: ENGINE LATHE, COLLET ATTACHMENT, 1/2" COLLET, 6" RULE, RIGHT HAND TURNING TOOL, LAYOUT INK, SCRIBE, WORK PIECE #3

TASK BREAKDOWN:

STEPS	KEY POINTS
1. LAY OUT WORK PIECE	1. APPLY INK 2. USE 6" RULE MEASURE 17/32" FROM END, REFER TO DRAWING 3. SCRIBE WORK PIECE
2. SET UP WORK PIECE	SET UP WORK PIECE #3 SAME AS WORK PIECE #2
3. SET UP TURNING TOOL	STANDARD RIGHT HAND
4. SET UP COMPOUND REST	1. ON 30° ANGLE 2. HANDLE TOWARD HEADSTOCK
5. TURN 30° ANGLE	1. TURN ON MACHINE 2. TURN ANGLE IN PROPER MANNER 3. CUT TO LAYOUT LINE NOTE: THIS IS A 60° INCLUDED ANGLE 4. STOP MACHINE 5. REMOVE WORK PIECE

HOLD FOR LAYOUT AND DRILL TASK

SKETCHES: DRAWING #1A, PART #3, PLANER JACK

REFERENCES: REF. #1, P. 36-25
REF. #2, PP. 483-484

TASK SHEET VII-A-4b(TS)

TASK: LAY OUT WORK PIECE FOR TURNING 3/4" DIAMETER

JOB: PLANER JACK

TRADE: MACHINIST

TOOLS AND MATERIALS: LAYOUT INK, SCRIBE, 6" RULE, WORK PIECE #4

TASK BREAKDOWN:

STEPS		KEY POINTS
1. LAY OUT LENGTH		NOTE: PART #4 IS TO BE MADE WITH THE BELL END OUT
	1.	INK WORK PIECE
	2.	USE 6" RULE
	3.	MEASURE 1 11/16" FROM END OF WORK PIECE NOTE: THIS LENGTH INCLUDES 1 9/16" LENGTH OF WORK PIECE PLUS 1/8" FOR THICKNESS OF CUT-OFF TOOL
	4.	SCRIBE WORK PIECE
2. LAY OUT OUTER END OF 3/4" DIAMETER	1.	USE 6" RULE
	2.	MEASURE 13/16" FROM END NOTE: THIS IS THE POINT AT WHICH THE 3/4" DIAMETER WILL INTERSECT THE ANGLE
	3.	SCRIBE WORK PIECE

SKETCHES: DRAWING 1A, PART #4, PLANER JACK

REFERENCES: INSTRUCTOR

TASK: TURN 3/4" DIAMETER TO LAYOUT LINES

JOB: PLANER JACK

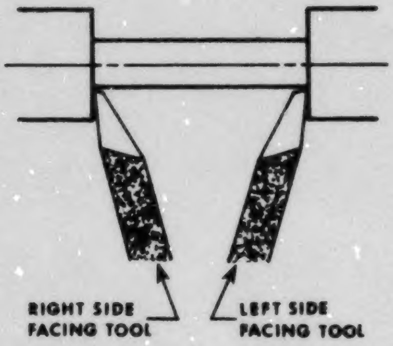
TRADE: MACHINIST

TOOLS AND MATERIALS: ENGINE LATHE, UNIVERSAL CHUCK, RIGHT-HAND TURNING TOOL, LEFT-HAND TURNING TOOL, 0-1" MICROMETER, 10" MILL FILE, WORK PIECE #4

TASK BREAKDOWN:

STEPS — KEY POINTS

1. SET UP



NOTE: THE TURNING TASK WILL REQUIRE THE USE OF BOTH RIGHT-HAND AND LEFT-HAND TURNING TOOLS

1. INSTALL RIGHT-HAND TURNING TOOL AND HOLDER IN POST
2. POSITION TOOL TO CUT SQUARE SHOULDER AT LEFT LAYOUT LINE
3. TIGHTEN TOOL POST
4. MOVE CARRIAGE AND POSITION TOOL NEAR RIGHT LAYOUT LINE

   NOTE: AUTOMATIC TRAVEL IS TO BE USED. CHECK MACHINE FOR TRAVEL AND PROPER DIRECTION TO LEFT

2. TURN DIAMETER

NOTE: TURN DIAMETER BETWEEN LAYOUT LINES

1. TURN MACHINE ON
2. PLUNGE TOOL INTO WORK PIECE .050"
3. ENGAGE AUTOMATIC FEED

   NOTE: BE SURE FEED IS SET TO TRAVEL CORRECT DIRECTION
4. DISENGAGE AUTOMATIC FEED WHEN TOOL IS NEAR LEFT LAYOUT LINE

   NOTE: DO NOT CROSS EITHER LAYOUT LINE
5. RETURN TOOL TO STARTING POSITION
6. REPEAT TURNING PROCEDURE
   a. HOLD TO 3/4" DIAMETER
   b. CHECK WITH MICROMETER
7. REMOVE RIGHT-HAND TURNING TOOL

STEPS	KEY POINTS
2. TURN DIAMETER (CON'T.)	8. INSTALL LEFT-HAND TURNING TOOL
	9. REVERSE AUTOMATIC FEED TRAVEL
	10. REPEAT PROCEDURE CUTTING TO RIGHT
	11. BLEND NEW CUT WITH 3/4" DIAMETER
	12. SQUARE RIGHT SHOULDER
3. DEBURR	USUAL PROCEDURE

SKETCHES: DRAWING #1A-PART #4, PLANER JACK

REFERENCES: SKETCH IN STEP #1

TASK SHEET

VII-A-4e(TS)

TASK:	LAY OUT 3/4" DIAMETER FOR 3/8" WIDE KNURL
JOB:	PLANER JACK
TRADE:	MACHINIST
TOOLS AND MATERIALS:	ENGINE LATHE, UNIVERSAL CHUCK, LAYOUT INK, SCRIBE, 6" RULE, WORK PIECE #4

TASK BREAKDOWN:

STEPS	KEY POINTS
1. LAY OUT RIGHT SIDE OF KNURL	1. INK 3/4" DIAMETER 2. USE 6" RULE 3. MEASURE 1/8" FROM RIGHT SHOULDER 4. SCRIBE LINE AROUND WORK PIECE 3/4" DIAMETER
2. LAY OUT LEFT SIDE OF KNURL	1. USE 6" RULE 2. MEASURE 3/8" FROM RIGHT SCRIBE LINE 3. SCRIBE LINE AROUND WORK PIECE 3/4" DIAMETER NOTE: THE 1/4" DIMENSION FROM LEFT LINE TO LEFT SHOULDER ALLOWS FOR 1/8" THICKNESS OF CUT-OFF TOOL

SKETCHES: DRAWING #1A, PART #4, PLANER JACK

REFERENCES: REF. #1, PP. 6-2 TO 6-3

TASK SHEET VII-A-41(TS)

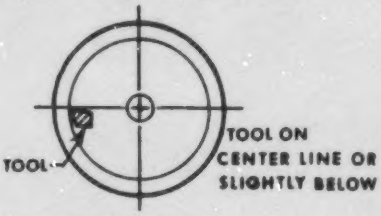
TASK: SET UP AND COUNTERBORE WORK PIECE

JOB: PLANER JACK

TRADE: MACHINIST

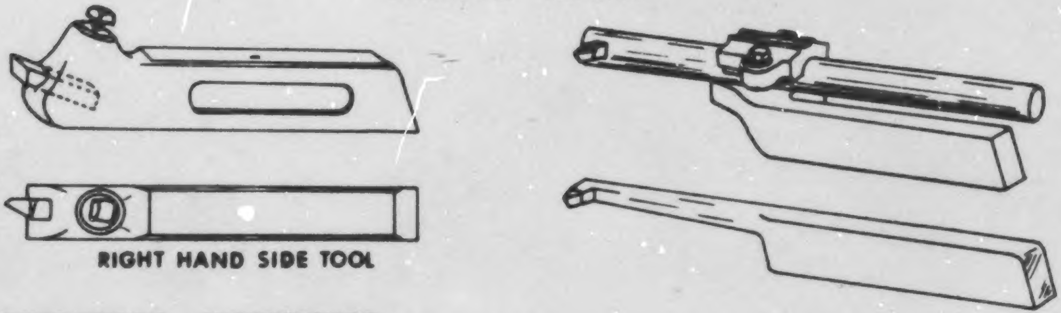
TOOLS AND MATERIALS: ENGINE LATHE, UNIVERSAL CHUCK, FACING TOOL, VERNIER CALIPER, DEPTH MICROMETER, WORK PIECE #4

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP FACING TOOL  	NOTE: A REGULAR FACING TOOL IS RECOMMENDED FOR SHALLOW COUNTERBORING TASKS 1. PLACE TOOL AND HOLD IN TOOL POST 2. POSITION TOOL TO CUT SQUARE SHOULDER NO RADII 3. TIGHTEN TOOL POST
2. COUNTERBORE	1. CHECK DIAMETER FREQUENTLY WITH VERNIER CALIPER 2. CHECK DEPTH FREQUENTLY WITH DEPTH MICROMETER 3. HOLD DIAMETER TO 1.126" 4. HOLD DEPTH TO .126" 5. MAINTAIN TOLERANCE TO .002" AS PER DRAWING
3. DEBURR	USUAL PROCEDURE

SKETCHES: DRAWING #1A, PART #4, PLANER JACK

BORING TOOLS



REFERENCES: INSTRUCTOR

TASK SHEET

VII-A-4J(TS)

TASK:	SET UP TO BORE 15° ANGLE
JOB:	PLANER JACK
TRADE:	MACHINIST
TOOLS AND MATERIALS:	ENGINE LATHE, UNIVERSAL CHUCK, BORING TOOLS, WORK PIECE #4

TASK BREAKDOWN

STEPS	KEY POINTS
1. SET UP BORING TOOL	1. REMOVE ANY TOOL FROM TOOL POST 2. SET UP BORING TOOL IN TOOL POST NOTE: USE LARGEST BAR AND SHORTEST BAR POSSIBLE
2. SET UP COMPOUND REST	1. SET COMPOUND REST ON 15° ANGLE 2. HANDWHEEL TOWARD TAILSTOCK AND FRONT OF MACHINE
3. POSITION TOOL	1. POSITION BORING TOOL NEAR 29/64" HOLE IN END OF WORK PIECE 2. LOCK CARRIAGE

SKETCHES: DRAWING #1A, PART #4 PLANER JACK

REFERENCES: REF. #1, PP. 36-34, 35
REF. #2, PP. 485-486

TASK SHEET VII-A-4k(TS)

TASK: BORE 15° ANGLE

JOB: PLANER JACK

TRADE: MACHINIST

TOOLS AND MATERIALS: ENGINE LATHE, UNIVERSAL CHUCK, BORING TOOLS, OIL CAN, OIL, VERNIER CALIPER, WORK PIECE #4

TASK BREAKDOWN:

STEPS	KEY POINTS
1. POSITION TOOL	1. MOVE CARRIAGE UNTIL TOOL IS INSIDE HOLE BUT NOT TOUCHING
	2. BRING CROSS SLIDE OUT UNTIL TOOL JUST TOUCHES
	3. TURN COMPOUND REST HANDWHEEL CLOCKWISE UNTIL TOOL IS OUT OF WORK PIECE
	4. LOCK CARRIAGE
2. BORE HOLE	1. BRING CROSS SLIDE OUT .010" BY THE DIAL
	2. SQUIRT OIL IN HOLE IN WORK PIECE
	3. START LATHE
	4. TURN COMPOUND REST HANDWHEEL CLOCKWISE UNTIL TOOL COMPLETES FIRST CUT
	5. TURN COMPOUND REST HANDWHEEL COUNTERCLOCKWISE UNTIL TOOL IS OUT OF WORK
	6. CONTINUE BORING PROCEDURE UNTIL HOLE IS 7/8" DIAMETER AT LARGE END NOTE: FINAL CUT IS TO BE FED SLOWLY TO OBTAIN SMOOTH FINISH
	7. FOLLOW MACHINING PROCEDURE

SKETCHES: DRAWING #1A, PART #4, PLANER JACK

REFERENCES: REF. #1, PP. 36-34 TO 36-35
REF. #2, PP. 485-486

TASK SHEET

VII-A-4m(TS)

TASK: CUT OFF WORK PIECE 1 9/16" LONG

JOB: PLANER JACK

TRADE: MACHINIST

TOOLS AND MATERIALS: ENGINE LATHE, UNIVERSAL CHUCK, CUT-OFF TOOL, 6" RULE, MILL FILE, WORK PIECE #4

TASK BREAKDOWN:

STEPS	KEY POINTS
1. CUT OFF WORK PIECE	1. SET UP CUT-OFF TOOL 2. CUT WORK PIECE OFF 1 9/16" LENGTH
2. CHAMFER	BEFORE WORK PIECE IS COMPLETELY SEVERED LAY FILE ON EACH END TO BREAK SHARP EDGES

HOLD FOR TAPPING

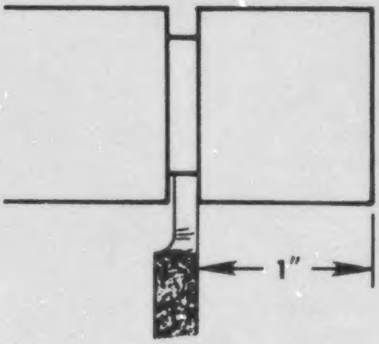
SKETCHES: DRAWING 1A, PART #4, PLANER JACK

REFERENCES: INSTRUCTOR

TASK SHEET VII-A-6e(TS)

TASK:	SET UP CUT-OFF TOOL AND TURN DIAMETER
JOB:	PLANER JACK
TRADE:	MACHINIST
TOOLS AND MATERIALS:	ENGINE LATHE, UNIVERSAL CHUCK, CUT-OFF TOOL, 6" RULE, VERNIER CALIPER, MILL FILE

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP TOOL	NOTE: IT IS NOT PRACTICAL TO USE A CUT-OFF TOOL FOR TURNING; HOWEVER, SOMETIMES IT IS NECESSARY 1. SET UP TOOL AS BEFORE, PERPENDICULAR TO WORK PIECE AND CENTERED 2. POSITION PARTING TOOL UNTIL RIGHT SIDE IS 1" FROM END OF WORK PIECE 3. LOCK CARRIAGE
2. SET UP MACHINE	SET MACHINE IN BACKGEARS
3. TURN DIAMETER  	NOTE: WHEN TURNING WITH A CUT-OFF TOOL, ONLY PLUNGE CUT 1. TURN MACHINE ON 2. TURN DIAMETER TO HOLD 1.124". HOLD CLOSE TOLERANCE AND SQUARE SHOULDER 3. LOOSEN CARRIAGE LOCK 4. TURN CARRIAGE LONGITUDINAL HANDWHEEL TO MOVE CUT-OFF TOOL ABOUT 1/32" TOWARD HEADSTOCK 5. LOCK CARRIAGE 6. PLUNGE TURN AGAIN TO BLEND WITH 1.124" DIAMETER NOTE: THE 1 1/8" TOTAL LENGTH WILL BE HELD LATER
4. DEBURR	USUAL PROCESS

SKETCHES: DRAWING #1A, PART #6, PLANER JACK

REFERENCES: INSTRUCTOR

JOB SHEET
ON
HORIZONTAL MILLING MACHINE

IX-A-1(J)

JOB: PLANER JACK

MATERIALS: PART #1 AS MACHINED ON LATHE, PART #7 AS MACHINED ON LATHE

TOOLS AND EQUIPMENT: HORIZONTAL MILLING MACHINE, UNIVERSAL VISE WITH "V" NOTCH IN STATIONARY JAW, END MILL HOLDER, 1/2" END MILL, 1/8" END MILL, PARALLEL BARS, DEPTH MICROMETER, 0-1" MICROMETER, DIAL INDICATOR, 6" RULE, 10" MILL FILE, ALLEN WRENCH SET

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REFERENCES: #1, PP. 38-1 TO 38-38 AND #2, PP. 524-564. STUDY THE JOB AND TASK SHEETS. CHECK WITH THE INSTRUCTOR BEFORE OPERATING MACHINE.

PROCEDURE AND/OR TASKS:	IX-A-1(TS)	CHECK MACHINE FOR PROPER OPERATING CONDITION
	IX-A-1a(TS)	SET UP UNIVERSAL VISE
		1. INDICATE TRUE
		2. JAWS PARALLEL TO TABLE
	*IX-A-1b(TS)	SET VISE UP ON 45° ANGLE
PART #1	*IX-A-1c(TS)	SET UP PART #1 IN VISE
	*IX-A-1d(TS)	SET UP MACHINE AND CUT 90° "V"
PART #7	IX-A-2(TS)	SET VISE UP FLAT (NO ANGLE)
	IX-A-2a(TS)	SET UP PART #7 SAME AS PART #1
	IX-A-2b(TS)	SET UP 1/8" END MILL
	IX-A-2c(TS)	CUT 1/8" WIDE X 1/4" DEEP SLOT
		1. IN PART #7
		2. CENTER END MILL ON PART #7
	*IX-A-2d(TS)	SET VISE ON 30° ANGLE
	IX-A-2e(TS)	SET UP 1/2" END MILL
	IX-A-2f(TS)	MILL ONE SIDE OF "V"
		1. SEE DRAWING #1A, PART #7
		2. SEE DRAWING ON TASK IX-A-2d(TS)
		3. BLEND WITH BOTTOM OF 1/8" X 1/4" CENTER CUT
	*IX-A-2g(TS)	SET VISE ON 60° ANGLE
	IX-A-2h(TS)	MILL OPPOSITE SIDE OF "V"
		1. SEE DRAWING #1A, PART #7
		2. SEE DRAWING ON TASK IX-A-2g(TS)
		3. BLEND WITH BOTTOM OF 1/8" X 1/4" CENTER CUT

4. DEBURR PART

IX-A-21(TS) CLEAN WORK STATION

HOLD PART FOR ASSEMBLY

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS.

1. CHECK MACHINE FOR PROFER OPERATION.
2. CHECK MACHINE FOR PROPER SETUP.
3. ALL DIMENSIONS HELD TO DRAWING SPECIFICATIONS.
4. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS.

TASK: SET VISE UP ON 45° ANGLE

JOB: PLANER JACK

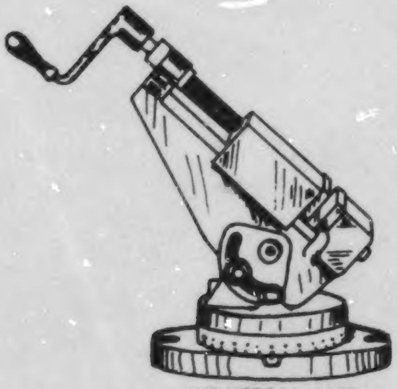
TRADE: MACHINIST

TOOLS AND MATERIALS: HORIZONTAL MILLING MACHINE, HAND TOOLS, UNIVERSAL VISE WITH "V" NOTCH IN STATIONARY JAW

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP VISE	1. LOOSEN ANGLE LOCKING BOLT 2. RAISE HANDLE END OF VISE 3. CHECK GAUGE ON SIDE OF VISE 4. ALIGN VISE ON 45° ANGLE 5. TIGHTEN ANGLE LOCKING BOLT 6. RECHECK VISE a. JAWS PARALLEL TO TABLE b. VISE AT 45° ANGLE
2. CLEAN VISE	1. USE CLEAN LINT FREE RAG 2. WIPE VISE JAWS CLEAN

SKETCHES: DRAWING #1A, PLANER JACK



UNIVERSAL VISE

REFERENCES: REF. #1, P. 36-18
REF. #2, P. 535

TASK SHEET IX-A-1c(TS)

TASK: SET UP PART #1 IN VISE

JOB: PLANER JACK

TRADE: MACHINIST

TOOLS AND MATERIALS: HORIZONTAL MILLING MACHINE, UNIVERSAL VISE, WORK PIECE #1

TASK BREAKDOWN:

STEPS	KEY POINTS
1. POSITION WORK PIECE	1. OPEN VISE JAWS 2. PLACE WORK PIECE IN VISE LARGE END UP 3. HEAD SLIGHTLY ABOVE VISE JAWS 4. WORK PIECE IS TO BE FIRMLY SEATED IN "V"
2. TIGHTEN VISE	AS THERE IS VERY LITTLE HOLDING AREA BETWEEN VISE AND WORK PIECE TIGHTEN VISE EXTREMELY TIGHT
3. MAKE FINAL CHECK	1. WORK PIECE SQUARE WITH VISE 2. VISE AT 45° ANGLE 3. VISE JAWS PARALLEL WITH TABLE

SKETCHES: DRAWING #1A, PART #1, PLANER JACK

REFERENCES: REF. #1, P. 36-18
REF. #2, P. 535

TASK SHEET IX-A-1d(TS)

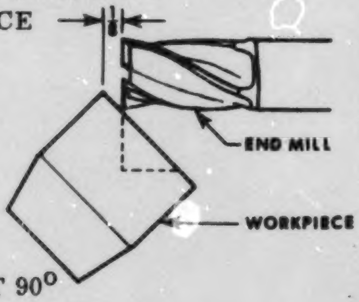
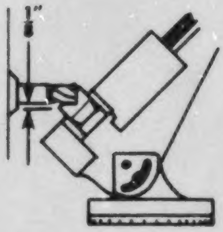
TASK: SET UP MACHINE AND CUT 90° "V"

JOB: PLANER JACK

TRADE: MACHINIST

TOOLS AND MATERIALS: HORIZONTAL MILLING MACHINE, UNIVERSAL VISE, 1/2" END MILL AND HOLDER, 6" RULE, 10" MILL FILE, WORK PIECE #1

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP MACHINE	1. POSITION 1/2" END MILL AND HOLD IN HORIZONTAL MILL 2. TIGHTEN END MILL AND HOLDER 3. CHECK WITH INSTRUCTOR FOR MILL R.P.M. 4. SET R.P.M.
2. POSITION WORK PIECE 	1. TURN MACHINE ON 2. MOVE TABLE 3. LOCATE END OF END MILL 1/8" FROM EDGE OF WORK PIECE 4. REFER TO SKETCH
3. CUT 90° 	1. TAKE SMALL CUTS 2. HOLD TO 1/8" ON BOTTOM SIDE OF "V" AND WORK PIECE 3. REFER TO SKETCH
4. DEBURR	USUAL METHOD

SKETCHES: DRAWING #1A, PART #1, PLANER JACK

REFERENCES: INSTRUCTOR

TASK SHEET

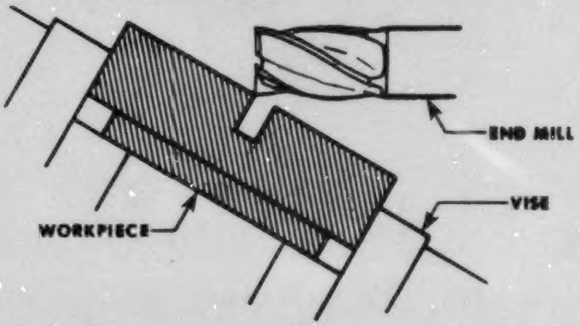
IX-A-2d(TS)

TASK:	SET VISE ON 30° ANGLE
JOB:	PLANER JACK
TRADE:	MACHINIST
TOOLS AND MATERIALS:	HORIZONTAL MILLING MACHINE, UNIVERSAL VISE, END MILL AND HOLDER, COMBINATION SQUARE, HAND TOOLS, PART #7

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP VISE	1. VISE ALREADY POSITIONED ON TABLE 2. LOOSEN VISE ANGLE LOCKING NUT WITH WRENCH 3. RAISE VISE HANDLE TILTING VISE TO 30° ANGLE 4. TIGHTEN VISE ANGLE LOCKING NUT WITH WRENCH
2. CHECK VISE ANGLE	1. SET COMBINATION SQUARE PROTRACTOR ON 30° 2. SLIDE PROTRACTOR TO RIGHT ON BLADE 3. CLEAN END OF BLADE ABOVE FLAT SURFACE OF PROTRACTOR 4. PLACE PROTRACTOR FLAT SURFACE ON MILL TABLE 5. POSITION BLADE OF SQUARE ON TOP OF WORK PIECE NOTE: IF BLADE IS FLUSH WITH TOP OF WORKPIECE, VISE AND WORK PIECE ARE PROPERLY POSITIONED

SKETCHES: DRAWING #1A, PART #7, PLANER JACK



REFERENCES: INSTRUCTOR

TASK SHEET

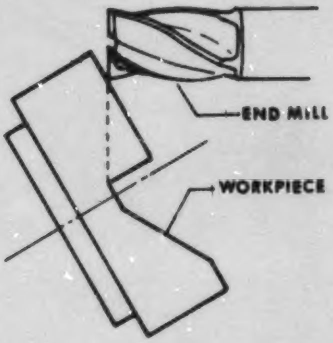
IX-A-2g(TS)

TASK:	SET VISE ON 60° ANGLE
JOB:	PLANER JACK
TRADE:	MACHINIST
TOOLS AND MATERIALS:	HORIZONTAL MILLING MACHINE, UNIVERSAL VISE END MILL AND HOLDER, COMBINATION SQUARE, PART #7

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP VISE	1. VISE ALREADY POSITIONED ON TABLE 2. LOOSEN VISE ANGLE LOCKING NUT WITH WRENCH 3. RAISE VISE HANDLE TILTING VISE TO 60° ANGLE 4. TIGHTEN VISE LOCKING NUT WITH WRENCH
2. CHECK VISE ANGLE	1. SET COMBINATION SQUARE PROTRACTOR ON 60° 2. SLIDE PROTRACTOR TO RIGHT ON BLADE 3. CLEAR END OF BLADE ABOVE FLAT SURFACE OF PROTRACTOR 4. PLACE PROTRACTOR FLAT SURFACE ON MILL TABLE 5. POSITION BLADE OF SQUARE ON TOP OF WORK PIECE NOTE: IF BLADE IS FLUSH WITH TOP OF WORK PIECE, VISE AND WORK PIECE ARE PROPERLY POSITIONED

SKETCHES: DRAWING #1A, PART #7, PLANER JACK



REFERENCES: INSTRUCTOR

VI-A-1(J)

JOB SHEET
ON
DRILL PRESS

JOB: PLANER JACK

MATERIALS: PART #2 AND PART #3 AS TURNED ON LATHE

TOOLS AND EQUIPMENT: DRILL PRESS, 3/16" DRILL, CHUCK AND KEY, BALL PEEN HAMMER, LAYOUT TOOLS, CENTERPUNCH, 10" MILL FILE

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB STUDY JOB SHEET AND READ REFERENCES: #1, LAYOUT, PP. 6-1 TO 6-10, #1, DRILLING, PP. 34-1 TO 34-24, #2, LAYOUT, PP. 62-72, #2, DRILLING, PP. 193-249. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE.

PROCEDURE AND/OR TASKS:

VI-A-1 (TS) LAY OUT CENTER LINE FOR 3/16" HOLES
1. PARTS #2 AND #3
2. 1 7/8" FROM 1/2" END OF PARTS
3. CENTERPUNCH

VI-A-1a (TS) CHECK DRILL PRESS FOR PROPER OPERATING CONDITION

VI-A-1b (TS) SET UP PARTS #2 AND #3
1. DRILL 3/16" HOLES
2. DEBURR

VI-A-1c (TS) CLEAN WORK STATION

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASK.

1. PARTS LAY OUT ACCORDING TO SPECIFICATIONS.
2. CHECK MACHINE FOR PROPER OPERATING CONDITION.
3. CHECK MACHINE FOR PROPER SETUP.
4. ALL DIMENSIONS HELD TO DRAWING SPECIFICATIONS.
5. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS.

TASK SHEET VII-A-8(TS)

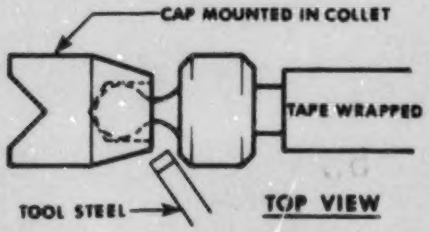
TASK: SET UP AND FORM CAP ON BALL

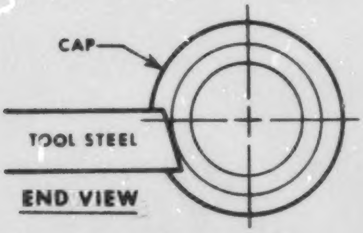
JOB: PLANER JACK

TRADE: MACHINIST

TOOLS AND MATERIALS: ENGINE LATHE, COLLET ATTACHMENT, 3/4" COLLET, NEW PIECE TOOL STEEL UNSHARPENED, MASKING TAPE, WORK PIECE #1 AND WORK PIECE #2, STRAIGHT TOOL HOLDER

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP PART #1	1. SET UP 3/4" COLLET IN LATHE 2. POSITION PART #1 IN COLLET 3. DRILLED END PROTRUDING OUT OF COLLET 3/8" 4. TIGHTEN COLLET
2. SET UP TOOL	1. PLACE TOOL STEEL, UNSHARPENED, IN TOOL HOLDER UPSIDE DOWN 2. INSTALL TOOL HOLDER IN TOOL POST 3. ADJUST TOOL POST AND TOOL a. TOOL AT 45° ANGLE TOWARD HEADSTOCK b. TOOL CENTERED WITH WORK PIECE
3. SET SPEED	R.P.M. APPROXIMATELY 700
4. SET UP PART #2	1. WRAP THREADS WITH PADDING OF MASKING TAPE NOTE: TO PROTECT HAND 2. INSERT BALL OF PART #2 INTO HOLE OF PART #1 NOTE: BALL IS NOT TO BIND IN CAP DURING TURNING TASK PROCESS 3. HOLD TAPED THREADED END OF PART #2 IN THE RIGHT HAND DURING THE FORMING TASK
5. FORM CAP  CAP MOUNTED IN COLLET TAPE WRAPPED TOOL STEEL TOP VIEW	1. TURN ON MACHINE 2. POSITION TOOL AGAINST CAP (SEE SKETCH) 3. TURN CROSS SLIDE HANDLE CLOCKWISE

STEPS	KEY POINTS
5. FORM CAP (CON'T.)  	NOTE: THIS PROCESS IS TO REDUCE THE DIAMETER OF THE CAP OPENING 4. STOP MACHINE 5. CHECK FOR PROPER REDUCTION OF CAP DIAMETER AROUND BALL NOTE: CAP AND BALL ARE NOT TO BIND. CAP MUST ROTATE FREELY. CAP AND BALL MUST NOT SEPARATE.

ROUTE TO BENCH

SKETCHES: DRAWINGS #1 AND #1A, PLANER JACK

REFERENCES: INSTRUCTOR

IV-A-1(J)

JOB SHEET
ON
BENCH

JOB: PLANER JACK

MATERIALS: ALL SEVEN PARTS AS MACHINED

TOOLS AND EQUIPMENT: BENCH, BENCH VISE, 1/2"-20 TAPER TAP, TAP WRENCH, OIL CAN, OIL, TWO ALUMINUM BLOCKS, PART #4

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB STUDY JOB AND TASK SHEETS READ REFERENCES: #1, PP. 11-1 TO 11-7; REF. #2, PP. 244-247. CHECK WITH INSTRUCTOR BEFORE TAPPING HOLE.

PROCEDURE AND/OR TASKS:

*IV-A-1(TS) TAP HOLE

IV-A-1a(TS) ASSEMBLE ALL PARTS

1. AS PER DRAWING #1 PLANER JACK
2. PARTS #2 AND #3 ARE INTERCHANGEABLE
3. PARTS #5, #6, #7 ARE INTERCHANGEABLE

IV-A-1b(TS) CLEAN WORK STATION

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASK.

1. WORKPIECE PROPERLY MOUNTED IN VISE.
2. TAP RIGHT ANGLE TO HOLE IN PART #4.
3. PARTS ASSEMBLED PROPERLY.
4. PLANER JACK FUNCTIONS PROPERLY.

TASK SHEET

IV-A-1(TS)

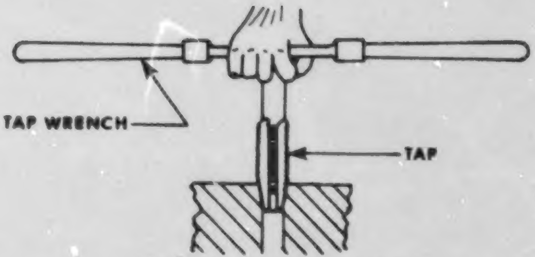
TASK:	TAP HOLE
JOB:	PLANER JACK
TRADE:	MACHINIST
TOOLS AND MATERIALS:	BENCH, BENCH VISE, TWO ALUMINUM BLOCKS, OIL CAN, TAP WRENCH, 1/2"-20 TAP, OIL, CLEAN RAGS, PART #4

TASK BREAKDOWN:

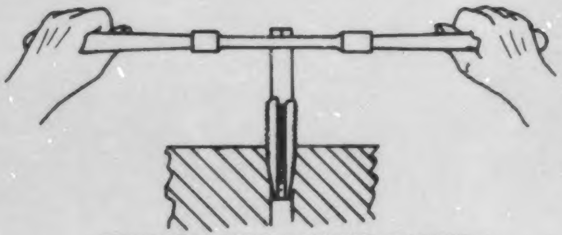
STEPS	KEY POINTS
1. SET UP WORK PIECE	1. OPEN VISE
	2. POSITION ONE ALUMINUM BLOCK AT EACH VISE JAW
	3. PLACE WORK PIECE BETWEEN ALUMINUM BLOCKS, SMALL END VERTICAL
	4. TIGHTEN VISE
2. TAP HOLE	1. POSITION SQUARE END OF TAP IN TAP WRENCH AND TIGHTEN
	2. GRASP TAP WRENCH WITH ONE HAND DIRECTLY OVER TAP
	3. PLACE TAP IN HOLE AND PRESS DOWN
	4. SCREW THE TAP INTO THE HOLE CLOCKWISE
	5. KEEP A STEADY DOWN PRESSURE ON THE TAP TO GET THREADS STARTED
	6. KEEP TAP SQUARE WITH WORK PIECE HOLE NOTE: REMOVE TAP HANDLE AND PLACE A SQUARE ON TOP OF THE WORK AND AGAINST THE TAP IN SEVERAL PLACES TO MAKE SURE TAP AND WORK PIECE ARE SQUARE
	7. REPLACE TAP HANDLE
	8. OIL TAP THREADS AND WORK PIECE
	9. GRASP BOTH ENDS OF THE TAP HANDLE
	10. WITH A SLOW STEADY MOVEMENT CONTINUE TO CUT THREADS
	11. BACK UP THE TAP AT INTERVALS a. TO BREAK AND CLEAR AWAY CHIPS

STEPS	KEY POINTS
2. TAP HOLE (CON'T.)	b. TO MAKE THREADS SMOOTH
	c. BACK UP ONE TURN
	d. GO AHEAD TWO TURNS

SKETCHES: DRAWING #1A, PART #4, PLANER JACK



START TAP IN THIS MANNER



COMPLETE TAPPING IN THIS MANNER

REFERENCES: REF. #1, P. 11-6
REF. #2, PP. 245-247

NAME ______________________

PROGRESS CHART
MACHINE SHOP – PART III

TASKS	SAW			BENCH							DRILL					SHAPER			MILLING MACHINE									ENGINE LATHE																							SURF GR.				TOOL GR		
JOB RADIUS CUTTER	VERTICAL BAND SAWING(ST.)	VERTICAL BAND SAWING(RADII)	HORIZONTAL BAND SAWING(ST.)	PREPARE SURFACE FOR LAYOUT	LAYOUT	BEND AND FORM	BROACH	TAP	HEAT TREAT	ASSEMBLE	DRILL TO LAYOUT	COUNTERBORE	COUNTERSINK	REAM	TAP	HORIZONTAL SHAPING	FORM SHAPING	ANGLE SHAPING	END MILLING	FACE MILLING	DRILLING	REAMING	INDEXING	SLITTING	SLOTTING	ANGLE MILLING	FORM MILLING	MOUNT WORK IN CHUCK	MOUNT WORK BETWEEN CENTERS	FACE	CENTER DRILL	TURN	TURN SHOULDER	TURN TAPER W/COMPOUND REST	TURN TAPER W/TAPER ATTACH.	DRILL	REAM	BORE	COUNTERBORING	GROOVE AND NECK	COUNTERSINK	TURN RADII	FORM	KNURL	CUT THREADS	HOB GEAR	CUT OFF	TAP	FILE	TAPER BORE	DRESS AND TRUE WHEEL	GRIND PLAIN SURFACE	GRIND ANGULAR SURFACE	GRIND SLOT	DRESS AND TRUE WHEEL	GRIND TAPER	GRIND STRAIGHT SURFACE
PART #1 SHANK																																																									
PART #2 WORM SCREW																																																									
PART #3 TOOL HOLDER																																																									
PART #4 SWIVEL SCREW																																																									

MACHINE SHOP RADIUS CUTTER

POWER HACK SAW	1
ENGINE LATHE	2
VERTICAL MILLING MACHINE	2
SHAPER	1
HORIZONTAL MILLING MACHINE	2
BENCH	2
BAND SAW	1
ARBOR PRESS	1
BELT SANDER	1
DRILL PRESS	2

AIM: THE STUDENT WILL BE ABLE TO SELECT MATERIALS, READ DRAWINGS, AND CONSTRUCT A RADIUS CUTTER ACCORDING TO SPECIFICATIONS: USING TOOLS, MATERIALS, EQUIPMENT, AND MACHINES CALLED FOR IN THE JOB.

CHECKING STANDARDS

1. SELECTION OF TOOLS, EQUIPMENT, AND SUPPLIES.
2. SET UP AND PREPARE MACHINE FOR JOB.
3. LAYOUT ACCORDING TO SPECIFICATIONS AND DRAWING.
4. HOLD ALL DIMENSIONS TO PRINT SPECIFICATIONS.
5. HOLD ALL SURFACES TO PRECISION FINISH.
6. HOLD SURFACE FINISH TO STANDARDS OF CRAFTSMANSHIP.
7. MAINTAIN TOOLS, MACHINES, AND EQUIPMENT IN GOOD WORKING ORDER AND REPAIR.
8. MAINTAIN AN ATTITUDE OF APPRECIATION FOR WORK, MATERIALS, TOOLS, EQUIPMENT, MACHINES, AND SPECIFICATIONS.
9. MAINTAIN SAFE WORKING HABITS.

REFERENCES

REF. #1, WALKER, JOHN R., MODERN METALWORKING

REF. #2, LUDWIG, OSWALD A. AND WILLARD J. MCCARTHY, METALWORK TECHNOLOGY AND PRACTICE

REF. #3, WALKER, JOHN R., MACHINING FUNDAMENTALS

REF. #4, MCCARTHY, WILLARD J. AND SMITH, ROBERT E., MACHINE TOOL TECHNOLOGY

REF. #5, KRAR, S.F., OSWALD, J.W., AND ST. AMAND, J.E., TECHNOLOGY OF MACHINE TOOLS

REF. #6, ANDERSON, JAMES AND TATRO, EARL E., SHOP THEORY

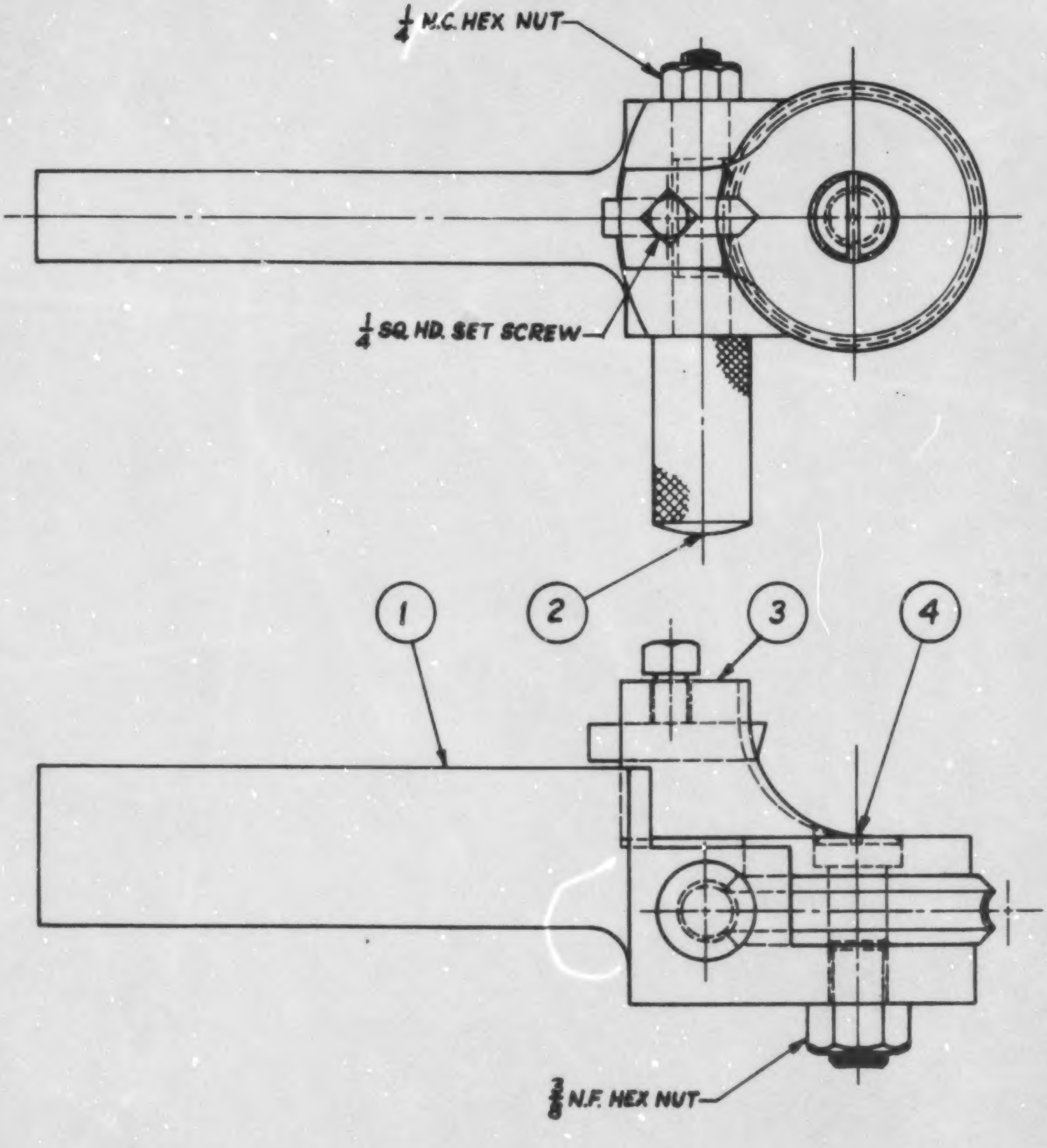
REF. #7, PORTER, HAROLD W., LASCOE, ORVILLE D., AND NELSON, CLYDE A., MACHINE SHOP OPERATIONS AND SETUPS

NOTE: IN THIS JOB THE STUDENT WILL GET THE MATERIAL FROM SUPPLY FOR EACH PART PRIOR TO THE CONSTRUCTION OF THAT PART. THE STUDENT IS CHARGED WITH KEEPING TRACK OF EACH COMPLETE PART AND THE PROPER STORAGE OF THAT PART TO PREVENT DAMAGE TO THE PART.

THE JOB AND TASK SHEETS ARE WRITTEN IN THE SEQUENTIAL ORDER OF CONSTRUCTING THE PART. UPON COMPLETION, THE PART WILL BE HELD FOR ASSEMBLY.

AT THIS STAGE OF TRAINING NO REFERENCE WILL BE MADE TO THOSE TASKS THAT HAVE BEEN PERFORMED REPEATEDLY IN PART I AND PART II. A TASK SHEET THAT IS WRITTEN WILL CONCERN ITSELF ONLY WITH THE TOTAL OPERATION OF A JOB RATHER THAN WITH SPECIFIC TASKS, AS WAS THE CASE IN PARTS I AND II. IN ADDITION, THOSE TASKS REQUIRING SPECIAL OPERATIONS OR SETUPS WILL BE WRITTEN. THE STUDENT IS EXPECTED TO FUNCTION PROPERLY WITH THIS METHOD.

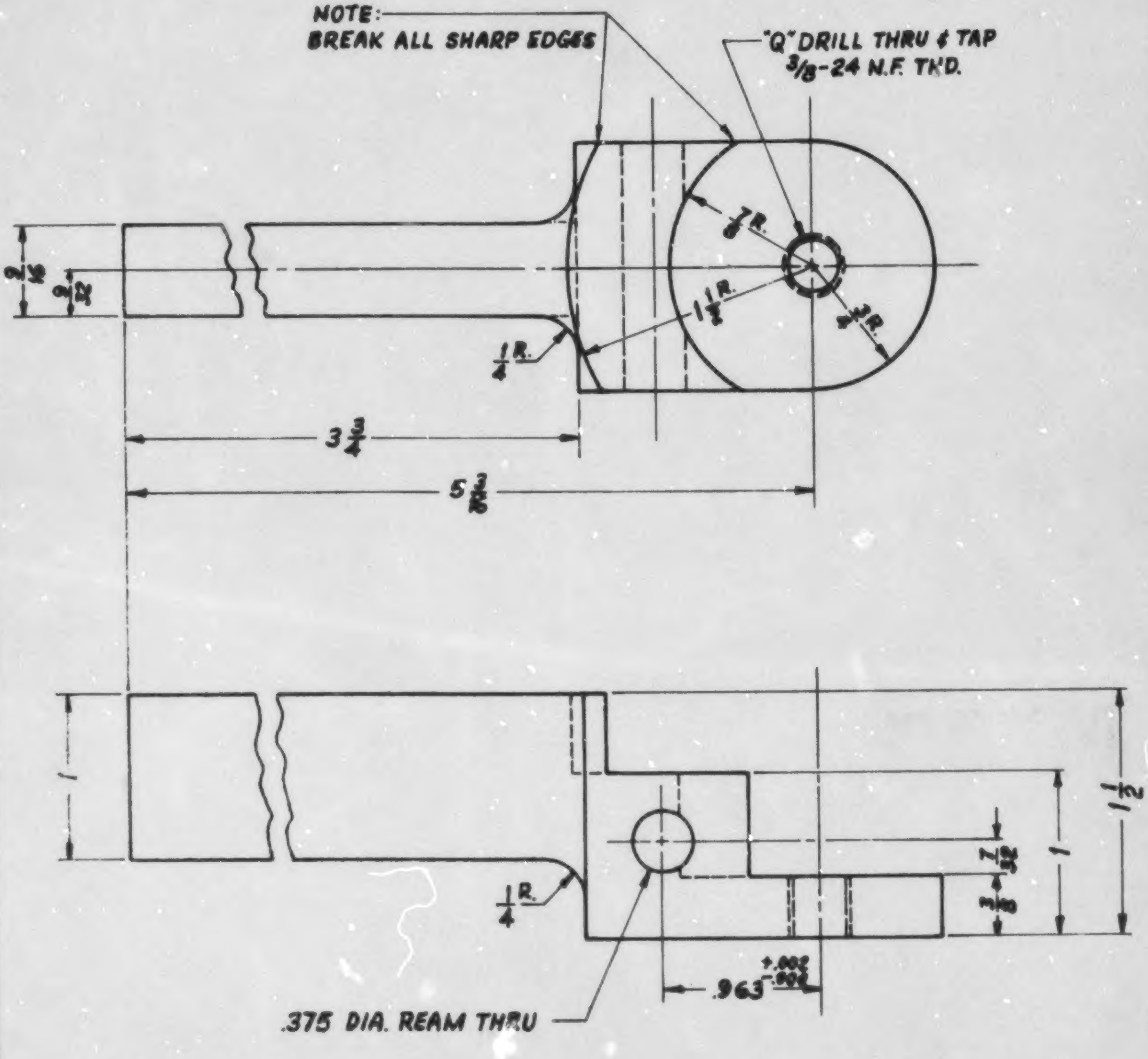
NOTE: ONLY THOSE TASKS WITH AN ASTERISK BY THEM WILL BE WRITTEN OUT COMPLETELY.



1/4 N.C. HEX NUT
1/4 SQ. HD. SET SCREW
1
2
3
4
3/8 N.F. HEX NUT

—ASSEMBLY—

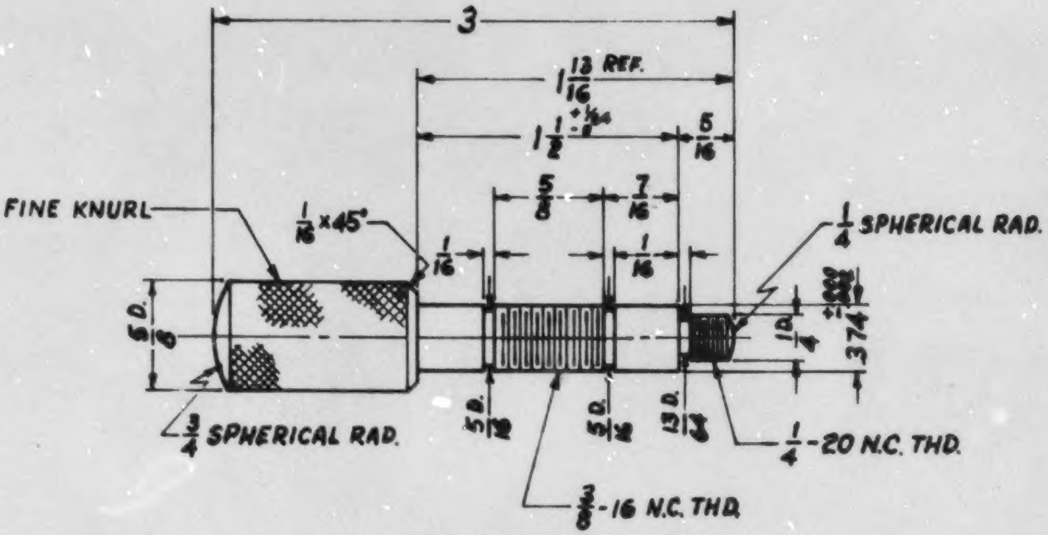
DRAWING NO. 2	RADIUS CUTTER	TOLERANCES UNLESS OTHERWISE NOTED
	MATERIAL: SEE DETAILS FINISH: SEE DETAILS SCALE: FULL SIZE	FRACTIONS - ± 1/64" DECIMAL - ± .005" ANGLES - ± 1/4°


NOTE:
BREAK ALL SHARP EDGES
"Q" DRILL THRU & TAP
3/8-24 N.F. THD.
7/8 R.
1 1/2 R.
3/4 R.
1/4 R.
21/32
9/32
3 3/4
5 3/16
1
1/4 R.
7/32
3/16
1
1 1/2
.963 +.002 -.000
.375 DIA. REAM THRU

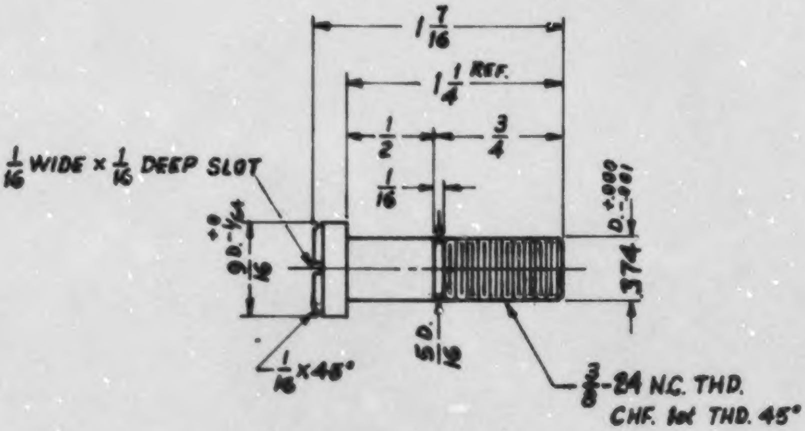
① SHANK ~ (1) REQ'D
MAT'L: MILD STEEL

POWER HACKSAW JOB NO. 2
BENCH JOB NO. 2
BAND SAW JOB NO. 1
BELT SANDER JOB NO. 1
ENGINE LATHE JOB NO. 2
DRILL PRESS JOB NO. 2

DRAWING NO. 2-A	SHANK	TOLERANCES UNLESS OTHERWISE NOTED
(SEE JOBS ABOVE)	MATERIAL: COLD ROLL STEEL FINISH: F.A.O. SCALE: FULL SIZE	FRACTIONS - ± 1/64" DECIMAL - ± .005" ANGLES - ± 1/4°

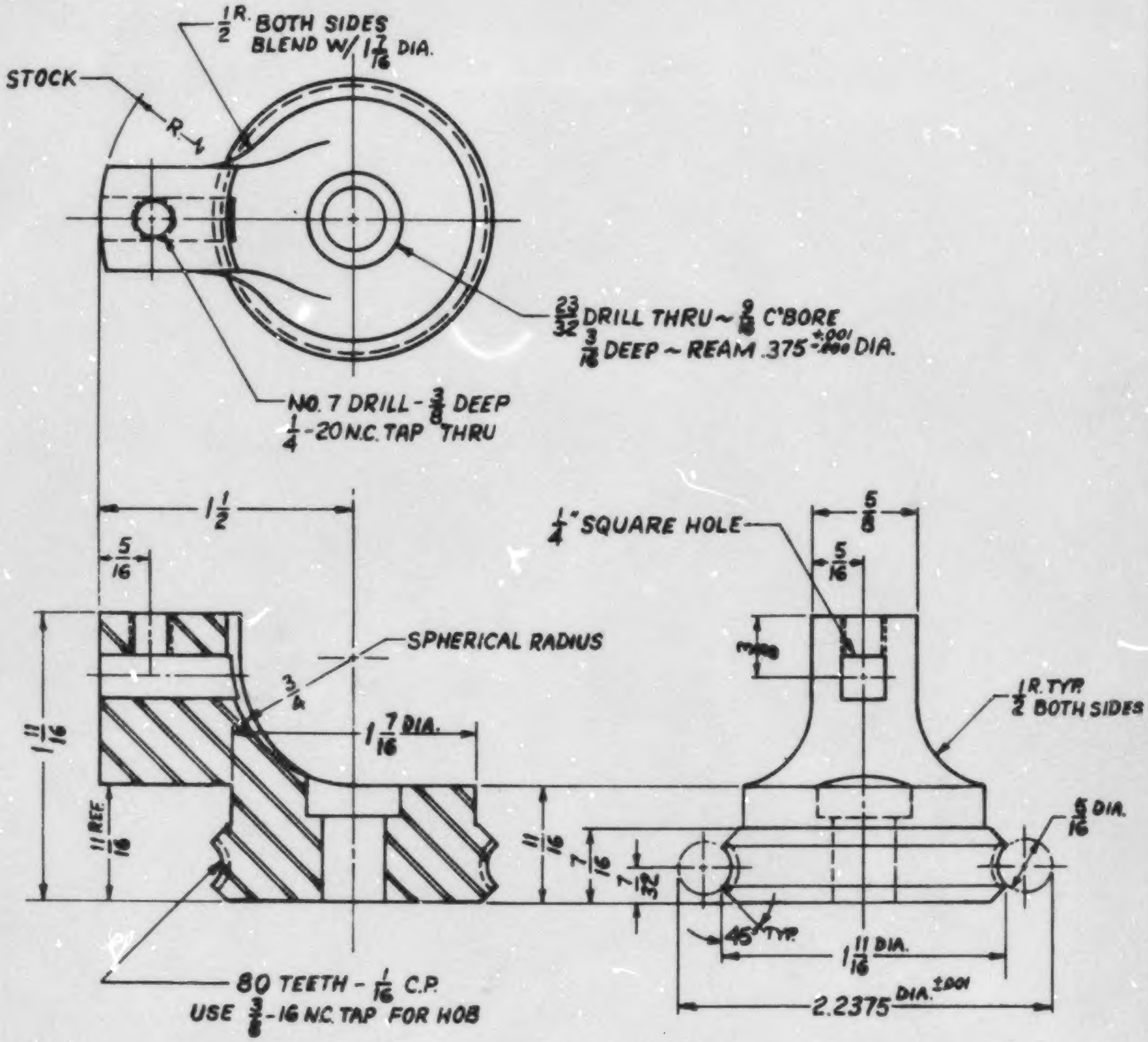

3
1 13/16 REF.
1 1/2 +1/64 -0
5/16
5/8
7/16
FINE KNURL
1/16 × 45°
1/16
1/16
1/4 SPHERICAL RAD.
.374 +.000 -.001
1/4 D.
5/8 D.
3/4 SPHERICAL RAD.
5/16 D.
5/16 D.
13/64 D.
1/4-20 N.C. THD.
3/8-16 N.C. THD.

② WORM ~ (1) REQ'D
MAT'L: MILD STEEL C.R.


1 7/16
1 1/4 REF.
1/2
3/4
1/16
1/16 WIDE × 1/16 DEEP SLOT
9/16 D. +0 -1/64
.374 D. +.000 -.001
1/16 × 45°
5/16 D.
3/8-24 N.C. THD.
CHF. 1st THD. 45°

④ SWIVEL SCREW ~ (1) REQ'D
MAT'L: MILD STEEL C.R.

DRAWING NO. 2-B	RADIUS CUTTER DETAILS	TOLERANCES UNLESS OTHERWISE NOTED
POWER HACKSAW JOB NO. 2 ENGINE LATHE JOB NO. 2 HORIZONTAL MILL JOB NO. 2	MATERIAL: NOTED FINISH: F.A.O. SCALE: FULL	FRACTIONS - ± 1/64" DECIMAL - ± .005" ANGLES - ± 1/4°


1/2 R. BOTH SIDES
BLEND W/ 1 7/16 DIA.
STOCK
R. 1/4
23/32 DRILL THRU ~ 9/16 C'BORE
3/16 DEEP ~ REAM .375 +.001 -.000 DIA.
NO. 7 DRILL - 3/8 DEEP
1/4 -20 N.C. TAP THRU
1 1/2
5/16
SPHERICAL RADIUS
3/4
1 7/16 DIA.
1 11/16
11/16 REF.
11/16
80 TEETH - 1/16 C.P.
USE 3/8 -16 NC TAP FOR HOB
1/4" SQUARE HOLE
5/8
5/16
3/16
1/2 R. TYP. BOTH SIDES
5/16 DIA.
7/16
7/32
45° TYP.
1 11/16 DIA.
2.2375 DIA. ±.001

③ TOOL HOLDER ~ (1) REQ'D
MAT'L: MILD STEEL

POWER HACK SAW JOB NO. 2
ENGINE LATHS JOB NO. 2
VERTICAL MILL JOB NO. 1
DRILL PRESS JOB NO. 2
BENCH JOB NO. 2

DRAWING NO. 2-C	TOOL HOLDER	TOLERANCES UNLESS OTHERWISE NOTED
(SEE JOBS ABOVE)	MATERIAL: COLD ROLL STEEL FINISH: TOOL SCALE: FULL SIZE	FRACTIONS - ± 1/64" DECIMAL - ± .005" ANGLES - ± 1/4 °

IV-B-1(J)

JOB SHEET
ON
BENCH

JOB: RADIUS CUTTER

MATERIALS: PART #1 - 1 1/2" X 1 1/2" X 6" C. R. SQUARE

TOOLS AND MATERIALS: SURFACE PLATE, LAYOUT INK, COMBINATION SQUARE, SCRIBE, PRICK PUNCH, CENTER PUNCH, BALL PEEN HAMMER, 6" RULE, DIVIDER, VERNIER HEIGHT GAGE, PARALLEL CLAMP, AND RIGHT ANGLE PLATE

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 57-65; REF. #5, PP. 53-63; REF. #1, PP. 6-1 TO 6-10. CHECK WITH INSTRUCTOR UPON COMPLETION OF LAYOUT

PROCEDURES AND/OR TASKS:

IV-B-1(TS) OBTAIN MATERIAL FROM SUPPLY

*IV-B-1a(TS) LAY OUT RADII AND HOLES

NOTE: LAY OUT 3/4" - 7/8" - 1 1/2" RADII

LAY OUT AND LOCATE REAMED AND TAPPED HOLE AS SPECIFIED

CAUTION: EXTREME CARE MUST BE TAKEN IN LAYOUT DUE TO CLOSE LOCATION TOLERANCES

ROUTE TO BAND SAW

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS

1. CHECK THE SELECTION AND CONDITION OF TOOLS USED
2. CHECK WORKPIECE FOR CLEAN SURFACES IN MAKING LAYOUT
3. CHECK SURFACE PLATE AND RIGHT ANGLE PLATE FOR CONDITION
4. HOLD ALL DIMENSIONS TO DRAWING SPECIFICATIONS AND TOLERANCES
5. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS

TASK SHEET

IV-B-1a(TS)

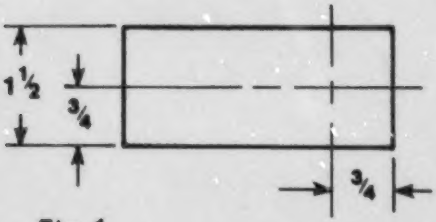
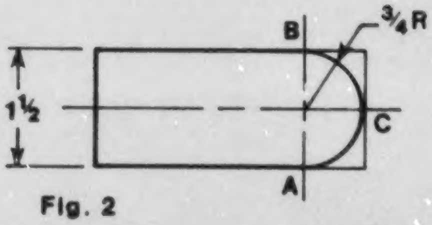
TASK: LAY OUT RADII AND HOLES

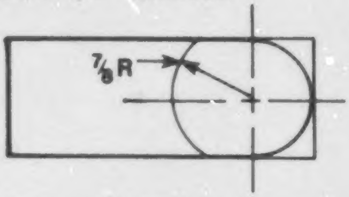
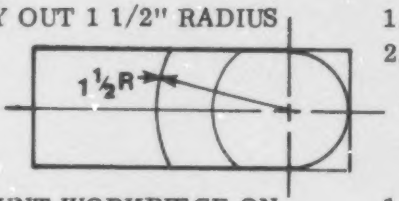
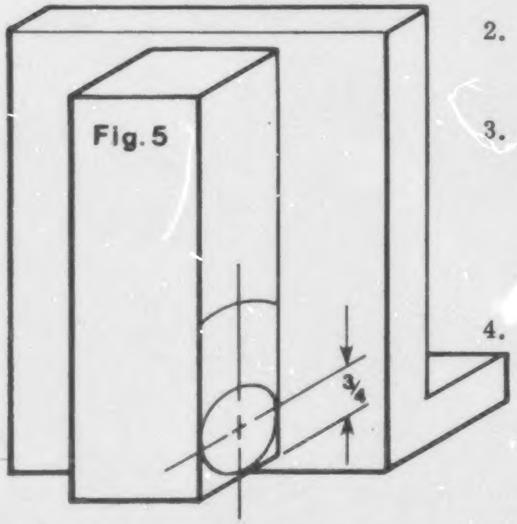
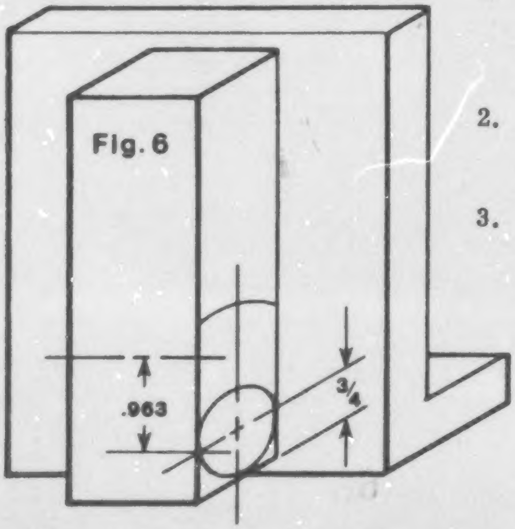
JOB: RADIUS CUTTER: PART #1: SHANK

TRADE: MACHINIST

TOOLS AND MATERIALS: SURFACE PLATE, LAYOUT INK, COMBINATION SQUARE, SCRIBE, PRICK PUNCH, CENTER PUNCH, BALL PEEN HAMMER, 6" RULE, DIVIDER, VERNIER HEIGHT GAGE, PARALLEL CLAMP, RIGHT ANGLE PLATE, AND PART #1: 1 1/2" X 1 1/2" X 6" C. R. SQUARE

TASK BREAKDOWN:

STEPS	KEY POINTS
1. INK WORKPIECE	1. WIPE METAL CLEAN 2. BRUSH OR SPRAY LAYOUT INK ON METAL 3. ALLOW INK TO DRY
2. LAY OUT CENTER NOTE: CENTER WILL BE FOR 3/4" R AND 3/8" TAPPED HOLE  Fig. 1	1. SET COMBINATION SQUARE ON 3/4" 2. SCRIBE LINE PARALLEL TO EDGE OF WORKPIECE 3/4" FROM EDGE. REFER TO FIG. 1 NOTE: THIS SHOULD BE THE CENTER LINE OF WORKPIECE NOTE: SCRIBE LINE THE FULL LENGTH OF WORKPIECE 3. WITH ONE END OF WORKPIECE AS A REFERENCE EDGE, SCRIBE LINE PERPENDICULAR TO FIRST LINE 3/4" FROM END. REFER TO FIG. 1 NOTE: SCRIBE LINE COMPLETELY ACROSS WORKPIECE NOTE: INTERSECTION OF THE TWO LINES WILL LOCATE THE CENTER 4. LOCATE CENTER WITH PRICK PUNCH NOTE: DO NOT CENTER PUNCH NOTE: THIS WILL BE THE CENTER FOR THE 3/8" 24 NF THREADED HOLE TO BE DRILLED AND TAPPED ON THE LATHE LATER
3. LAY OUT 3/4" RADII  Fig. 2	1. SET DIVIDER ON 3/4" 2. SCRIBE 3/4" RADIUS ARC NOTE: ARC WILL INTERSECT CENTER LINES AT POINTS A, B, AND C. REFER TO FIG. 2

STEPS	KEY POINTS
4. LAY OUT 7/8" RADIUS  Fig. 3	1. SET DIVIDER AT 7/8" 2. SCRIBE 7/8" RADIUS ARC AS PER DRAWING NOTE: SAME CENTER WILL BE USED TO LAY OUT 7/8" RADIUS AS FOR THE 3/4" RADIUS. REFER TO FIG. 3
5. LAY OUT 1 1/2" RADIUS  Fig. 4	1. SET DIVIDER AT 1 1/2" 2. SCRIBE 1 1/2" RADIUS ARC AS PER DRAWING NOTE: SAME CENTER WILL BE USED AS IN STEPS #3 AND 4. REFER TO FIG. 4
6. MOUNT WORKPIECE ON RIGHT ANGLE PLATE  Fig. 5	1. SET UP RIGHT ANGLE PLATE ON SURFACE PLATE NOTE: INSPECT BOTH PLATES FOR CONDITION AND WIPE FREE OF DIRT 2. SELECT PARALLEL CLAMP FOR CLAMPING WORKPIECE NOTE: C-CLAMP MAY BE USED 3. PLACE WORKPIECE AGAINST FACE OF ANGLE PLATE IN VERTICAL POSITION REFER TO FIG. 5 NOTE: SIDE WITH PREVIOUS LAYOUT OF RADII WOULD BE LOCATED ON RIGHT SIDE ADJACENT TO ANGLE PLATE 4. CLAMP WORKPIECE TO ANGLE PLATE NOTE: CLAMP WORKPIECE JUST ABOVE CENTER NOTE: CHECK WORKPIECE WITH SQUARE TO INSURE IT IS PERPENDICULAR TO SURFACE PLATE
7. LAY OUT CENTER LINE  Fig. 6	1. SLIDE VERNIER HEIGHT GAGE UP TO RIGHT SIDE OF WORKPIECE NOTE: SCRIBER WILL BE FACING SURFACE WITH LAYOUT OF RADII 2. ADJUST VERNIER UNTIL SCRIBER POINT COINCIDES WITH CENTER OF RADII AND 3/8" - NF 24 HOLE 3. RAISE THE SCRIBER .963" HIGHER NOTE: THIS IS THE DISTANCE BETWEEN THE CENTER OF THE 3/8" TAPPED HOLE AND 3/8" REAMED HOLE AS PER DRAWING. REFER TO FIG. 6

STEPS	KEY POINTS
	4. SCRIBE HORIZONTAL LINE ACROSS THE FACE OF THE FRONT SIDE OF WORKPIECE NOTE: THIS WILL ONLY LOCATE ONE CENTER LINE FOR THE 3/8" REAMED HOLE. THE VERTICAL CENTER LINE WILL BE LOCATED AFTER MACHINING THE OFFSETS ON THE WORKPIECE
8. CHECK LAYOUT ACCURACY	1. CHECK LOCATION OF THE CENTERS WITH SQUARE
	2. CHECK SIZE OF RADII WITH DIVIDER
	3. CHECK DIMENSION BETWEEN CENTERS
	4. INSPECT TO SEE THAT PRICK PUNCHED HOLE IS ACCURATELY PUNCHED ROUTE TO BAND SAW

SKETCHES: DRAWING #2-A; PART #1, SHANK, RADIUS CUTTER

REFERENCES: REF. #1, PP. 6-1 TO 6-10
REF. #2, PP. 57-65
REF. #3, PP. 53-63

V-A-1(J)

JOB SHEET
ON
BAND SAW

JOB: RADIUS CUTTER

MATERIALS: PART #1: 1 1/2" X 1 1/2" X 6" C. R. SQUARE WITH LAYOUT PREVIOUSLY MADE

TOOLS AND EQUIPMENT: VERTICAL BAND SAW, 5/16" WIDTH - 10P BLADE

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 313-325; REF. #4, PP. 159-174; REF. #5, PP. 99-112; REF. #6, PP. 277-300. CHECK WITH INSTRUCTOR ON SETUP OF MACHINE AND BLADE BEFORE BEGINNING THIS JOB, AND UPON COMPLETION OF SAWING THE RADIUS

PROCEDURES AND/OR TASKS:

V-A-1(TS)	CHECK BAND SAW FOR PROPER OPERATING CONDITION
V-A-1a(TS)	INSTALL PROPER BAND SAW BLADE NOTE: CHECK WITH INSTRUCTOR ON TYPE, ALTHOUGH A 5/16" WIDTH - 10P BLADE IS RECOMMENDED
*V-A-1b(TS)	SAW 3/4" RADIUS ROUTE TO BELT SANDER OR TOOL GRINDER

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS.

1. CHECK THE OPERATING CONDITION OF THE BAND SAW
2. CHECK THE BLADE FOR CONDITION, SIZE, PITCH, AND PROPER INSTALLATION
3. HOLD SAW CUT WITHIN 1/64" OF LAYOUT LINES
4. OBSERVE ALL SAFETY RULES AND REGULATIONS
5. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS

TASK SHEET V-A-1b(TS)

TASK: SAW 3/4" RADIUS

JOB: RADIUS CUTTER: PART #1: SHANK

TRADE: MACHINIST

TOOLS AND MATERIALS: VERTICAL BAND SAW, 5/16" WIDTH 10 PITCH BLADE AND PART #1: SHANK WITH LAYOUT PREVIOUSLY MADE

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP MACHINE	1. PROPER SELECTION OF BLADE 2. BLADE INSTALLED PROPERLY 3. SET BAND SAW VELOCITY IN FEET PER MINUTE 4. PLACE WORKPIECE ON TABLE 5. SET UPPER SAW GUIDE NOTE: GUIDE SHOULD BE ABOUT 1/4" ABOVE WORKPIECE 6. CHECK TRACKING OF BLADE 7. CUT ON AND ADJUST COOLANT FLOW IF APPLICABLE
2. SAW 3/4" RADIUS	1. START SAW NOTE: DO NOT FEED WORKPIECE INTO BLADE UNTIL MACHINE IS RUNNING AT FULL SPEED 2. BRING WORKPIECE IN CONTACT WITH SAW NOTE: TURN INTO LINE SLIGHTLY TO GET BLADE STARTED CAUTION: DO NOT APPLY SIDE PRESSURE AGAINIST BLADE 3. ADVANCE WORK SLOWLY FOLLOWING CONTOUR OF LAYOUT LINE NOTE: HOLD CUT ON OUTSIDE OF LAYOUT ABOUT 1/64" 4. FEED WORKPIECE SLOWLY ALLOWING SAW TO CUT AT ITS OWN RATE OF FEED CAUTION: DO NOT CROWD OR TWIST BLADE NOTE: WHERE POWER FEED IS APPLICABLE IT SHOULD BE USED 5. SAW ONE-HALF OF THE RADIUS

STEPS	KEY POINTS
	6. REPOSITION WORKPIECE AND SAW THE OTHER HALF
	7. CUT OFF SAW
	8. REMOVE WORKPIECE
	9. INSPECT
	10. REMOVE FILING AND SCRAP MATERIAL
	11. WIPE MACHINE DOWN
	12. ROUTE TO EITHER BELT SANDER OR TOOL GRINDER

SKETCHES: DRAWING #2-A; PART #1, SHANK, RADIUS CUTTER

REFERENCES: REF. #3, PP. 313-325
REF. #4, PP. 159-174
REF. #5, PP. 99-112
REF. #6, PP. 277-300

X-A-1(J)

JOB SHEET
ON
GRINDER

JOB: RADIUS CUTTER

MATERIALS: PART #1: SHANK AS MACHINED IN PREVIOUS TASK

TOOLS AND EQUIPMENT: DISC SANDER, SQUARE, AND 120 GRIT SANDING DISC
NOTE: THE TASK SHEET WILL BE WRITTEN ON THE USE OF THE DISC SANDER, ALTHOUGH A TOOL GRINDER OR BELT SANDER CAN BE USED EQUALLY AS WELL

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB, CHECK WITH THE INSTRUCTOR ON THE MACHINE TO BE USED AND THE ABRASIVE DISC GRIT TO USE

PROCEDURES AND/OR TASK:

X-A-1(TS)	CHECK DISC SANDER FOR PROPER OPERATING CONDITION
*X-A-1a(TS)	GRIND 3/4" RADIUS
	ROUTE TO ENGINE LATHE

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS

1. CHECK THE OPERATING CONDITION OF DISC SANDER
2. CHECK FOR CORRECT SANDING DISC AND PROPERLY INSTALLED
3. CHECK TO INSURE TABLE IS PERPENDICULAR TO DISC
4. ALL SAFETY RULES AND REGULATIONS OBSERVED
5. HOLD GRINDING CONTOUR TO LAYOUT LINES
6. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS

TASK SHEET

X-A-1a(TS)

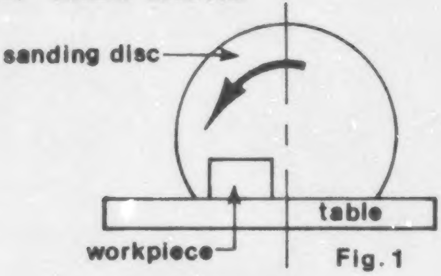
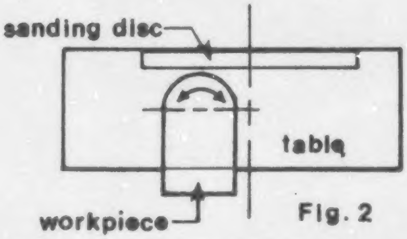
TASK: GRIND 3/4" RADIUS

JOB: RADIUS CUTTER: PART #1 - SHANK

TRADE: MACHINIST

TOOLS AND MATERIALS: DISC SANDER, SQUARE, 120 GRIT GRINDING DISC, AND PART #1 - SHANK AS MACHINED IN PREVIOUS TASK

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP DISC SANDER	1. CHECK OPERATING CONDITION 2. INSPECT SANDING DISC FOR CONDITION AND CORRECT GRIT NOTE: REPLACE IF NECESSARY. SEE INSTRUCTOR FOR PROPER PROCEDURE 3. CHECK TABLE WITH DISC FOR CORRECT ANGLE NOTE: TABLE MUST BE PERPENDICULAR TO THE DISC
2. GRIND RADIUS  Fig. 1  Fig. 2	1. CUT DISC GRINDER ON 2. POSITION WORKPIECE ON TABLE 3. FEED WORKPIECE INTO SANDING DISC CAUTION: FEED WORKPIECE IN ON THE SIDE OF DISC THAT WILL PULL THE WORKPIECE DOWN. REFER TO FIG. 1 4. SLOWLY REVOLVE WORKPIECE FROM ONE SIDE OF RADIUS TO THE OTHER. REFER TO FIG. 2 NOTE: APPLY LIGHT TO FIRM PRESSURE CAUTION: DO NOT SAND ACROSS LAYOUT LINE 5. CONTINUE UNTIL RADIUS IS SANDED SMOOTH AND TO THE LAYOUT LINE 6. BURR EDGES
3. GRIND OPPOSITE END	1. GRIND END SQUARE 2. HOLD 5 15/16" OVER LENGTH 3. INSPECT FOR SQUARNESS AND LENGTH

SKETCHES: DRAWING #2-A; PART #1, SHANK, RADIUS CUTTER

REFERENCES: SEE THE INSTRUCTOR

VII-B-1(J)

JOB SHEET
ON
ENGINE LATHE

JOB: RADIUS CUTTER

MATERIALS: PART #1: SHANK AS MACHINED IN PREVIOUS TASKS

TOOLS AND EQUIPMENT: ENGINE LATHE, INDEPENDENT CHUCK, LIVE CENTER, DIAL INDICATOR, R. H. FACING TOOL, 6" RULE, DEPTH MICROMETER, AND MILL FILE

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB, READ REF. #3, PP. 135-184; REF. #4, PP. 217-282; REF. #5, PP. 141-182. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE

PROCEDURES
8 **AND/OR TASKS:**

VII-A-1(TS)	CHECK ENGINE LATHE FOR PROPER OPERATING CONDITION
*VII-B-1(TS)	SET UP AND TRUE WORKPIECE
*VII-B-1a(TS)	DRILL AND TAP HOLE NOTE: DRILL AND TAP 3/8" - 24 NF HOLE
*VII-B-1b(TS)	TURN RADII: 7/8" AND 1 1/2" ROUTE TO MILLING MACHINE

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS

1. CHECK THE OPERATING CONDITION OF ENGINE LATHE
2. WORKPIECE CHUCKED SECURELY AND TRUED PROPERLY
3. SELECTION OF TOOLS, EQUIPMENT, AND SUPPLIES
4. OBSERVANCE OF ALL SAFETY RULES AND REGULATIONS
5. ALL DIMENSIONS HELD TO SPECIFICATION AND TOLERANCE
6. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS

TASK SHEET

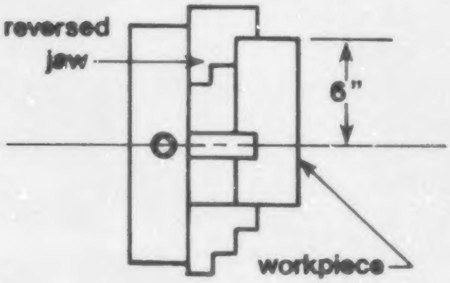
TASK: SET UP AND TRUE WORKPIECE

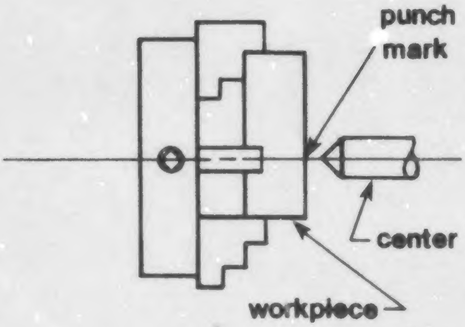
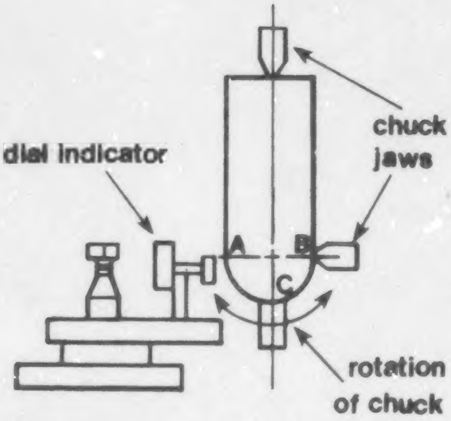
JOB: RADIUS CUTTER: PART #1 - SHANK

TRADE: MACHINIST

TOOLS AND MATERIALS: ENGINE LATHE, R. H. FACING TOOL, INDEPENDENT CHUCK, LIVE CENTER, DIAL INDICATOR, CENTER DRILL, DRILL CHUCK, "Q" DRILL, 3/8" - 24 NF TAPER TAP, 6" RULE, DEPTH MICROMETER, BRASS HAMMER, MILL FILE, AND PART #1: SHANK AS MACHINED IN PREVIOUS TASK

TASK BREAKDOWN:

STEPS	KEY POINTS
1. MOUNT INDEPENDENT CHUCK	1. CLEAN SPINDLE NOSE 2. CLEAN ALL MATING PARTS ON CHUCK 3. PLACE CHUCK ON CRADLE BLOCK 4. SLIDE CHUCK INTO PLACE 5. MOUNT CHUCK ON SPINDLE NOTE: METHOD OF FASTENING WILL BE DETERMINED BY TYPE OF SPINDLE NOSE
2. REVERSE ONE JAW ON CHUCK  Fig. 1	NOTE: JAW IS REVERSED TO PERMIT RECTANGULAR WORKPIECE TO BE CHUCKED OFF CENTER 1. TURN ADJUSTING SCREW OF ONE JAW COUNTERCLOCKWISE 2. TURN COUNTERCLOCKWISE UNTIL JAW IS COMPLETELY BACKED OUT 3. REVERSE JAW END FOR END 4. TURN ADJUSTING SCREW SLOWLY CLOCKWISE UNTIL JAW THREADS CATCH 5. ADJUST UNTIL APPROXIMATELY 6" FROM CENTER OF LATHE REFER TO FIG. 1
3. CHUCK WORKPIECE	1. ADJUST THE TWO JAWS ADJACENT TO THE REVERSED JAW UNTIL THEY ARE APPROXIMATELY 1 1/2" APART AND CENTERED 2. ADJUST JAW OPPOSITE FROM REVERSED JAW UNTIL APPROXIMATELY 3/4" FROM CENTER OF LATHE

STEPS	KEY POINTS
 Fig. 2	3. PLACE WORKPIECE IN CHUCK AND TIGHTEN ALL FOUR JAWS SLIGHTLY NOTE: TIGHTEN JAWS UNIFORMLY 4. PLACE CENTER IN TAILSTOCK NOTE: WIGGLER OR CENTER FINDER MAY BE USED 5. SLIDE TAILSTOCK FORWARD UNTIL CENTER POINT IS ABOUT 1/16" FROM WORKPIECE REFER TO FIG. 2 NOTE: THE PURPOSE OF THE CENTER IS TO ASSIST IN ALIGNING WORKPIECE 6. ADJUST ALL FOUR JAWS UNTIL CENTER POINT IS ALIGNED WITH PRICK PUNCH MARK 7. TIGHTEN JAW FIRMLY NOTE: THIS IS AN APPROXIMATE TRUING. DO NOT DO ANY MACHINING AT THIS POINT
4. TRUE WORKPIECE  chuck jaws dial indicator A B C rotation of chuck Fig. 3	1. ASSEMBLE DIAL INDICATOR 2. MOUNT DIAL INDICATOR IN TOOL POST 3. POSITION DIAL INDICATOR SO THE CONTACT POINT IS PERPENDICULAR TO WORKPIECE 4. TURN CHUCK UNTIL 3/4" RADIUS IS POINTED DOWN 5. MOVE CARRIAGE AND CROSS FEED SO AS TO POSITION CONTACT POINT AGAINST WORKPIECE AT POINT "A" REFER TO FIG. 3 6. ZERO DIAL INDICATOR 7. TURN CHUCK BY HAND UNTIL DIAL INDICATOR IS AT POINT "C" 8. CHECK INDICATOR READING 9. TURN CHUCK BY HAND UNTIL POINT "B" IS REACHED 10. CHECK INDICATOR READING 11. MAKE NECESSARY ADJUSTMENTS IN CHUCK JAWS UNTIL INDICATOR READING IS THE SAME AT CONTACT POINTS "A", "B", AND "C" 12. TIGHTEN CHUCK JAWS 13. RECHECK WORKPIECE FOR TRUE

STEPS	KEY POINTS
5. TRUE WORKPIECE FACE	1. ASSEMBLE DIAL INDICATOR AND TOOL POST ADAPTOR 2. POSITION DIAL INDICATOR SO CONTACT POINT IS FACING THE FACE OF WORKPIECE SEE FIG. 4 3. TURN CHUCK BY HAND UNTIL WORKPIECE IS IN HORIZONTAL POSITION NOTE: ONE END WILL FACE OPERATOR 4. MOVE CARRIAGE TO THE LEFT UNTIL CONTACT POINT MAKES CONTACT WITH WORKPIECE FACE NOTE: SHOW ABOUT .005" READING ON INDICATOR DIAL 5. ZERO DIAL INDICATOR 6. TURN CROSS FEED KNOB CLOCKWISE TO MOVE CONTACT POINT COMPLETELY ACROSS WORKPIECE REFER TO FIG. 4 NOTE: MOVE CONTACT POINT FROM ONE END TO THE OTHER 7. MAKE ANY ADJUSTMENTS BY TAPPING FACE OF WORKPIECE WITH BRASS HAMMER CAUTION: NO NOT LEAVE CONTACT POINT IN CONTACT WITH WORKPIECE WHEN TAPPING WITH HAMMER NOTE: DO NOT LOOSEN CHUCK JAWS 8. TRUE WORKPIECE BY TAPPING THE HIGH POINT AND CHECKING WITH INDICATOR 9. ROTATE CHUCK 90° NOTE: WORKPIECE WILL BE IN VERTICAL POSITION 10. MOVE CONTACT POINT NEAR END OF WORKPIECE NOTE: AFTER TRUING WORKPIECE 11. CHECK FACE OF WORKPIECE FOR TRUENESS NOTE: TAP HIGH EDGE IN. RECHECK REFER TO FIG. 5

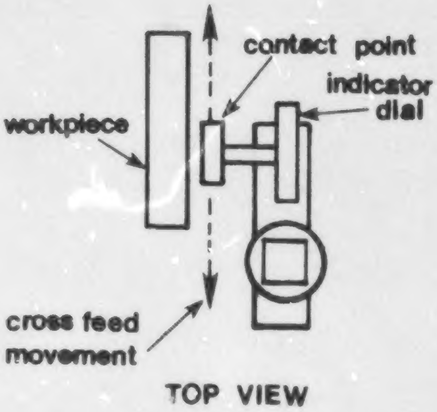

contact point
indicator dial
workpiece
cross feed movement
TOP VIEW

Fig. 4

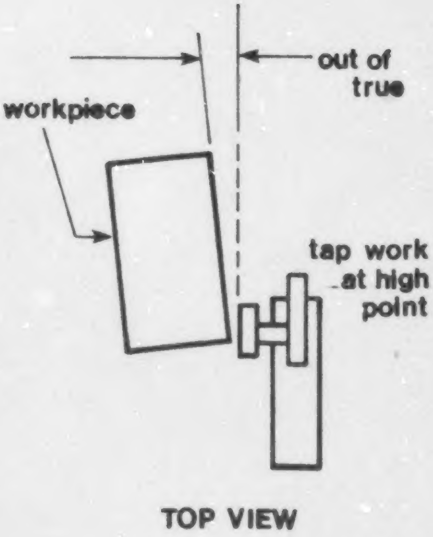

out of true
workpiece
tap work at high point
TOP VIEW

Fig. 5

STEPS	KEY POINTS
	12. RECHECK FACE OF WORKPIECE IN BOTH DIRECTIONS FOR SQUARE AND TRUENESS
	13. RECHECK 3/4" RADIUS FOR TRUE
	14. SNUG JAWS TIGHT
	15. REMOVE DIAL INDICATOR AND TOOL POST ADAPTORS
	16. CLEAN AND REPLACE INDICATOR IN PROPER STORAGE PLACE
	17. HOLD FOR FACING RADII AND DRILLING AND TAPPING HOLE

SKETCHES: DRAWING #2A; PART #1, SHANK: RADIUS CUTTER

REFERENCES: REF. #3, PP. 164-168
REF. #4, PP. 260-265
REF. #5, PP. 168-170

TASK SHEET

VII-B-1a(TS)

TASK: DRILL AND TAP HOLE

JOB: RADIUS CUTTER: PART #1 - SHANK

TRADE: MACHINIST

TOOLS AND MATERIALS: CENTER DRILL, DRILL CHUCK, "Q" DRILL, 3/8" - 24 NF TAPER TAP, TAP WRENCH, CENTER, THREADING OIL, AND PART #1 AS MACHINED PREVIOUSLY AND CHUCKED TRUE IN LATHE

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP WORKPIECE	AS PER TASK VII-B-1(TS) NOTE: WORKPIECE IS MOUNTED IN CHUCK CENTERED AND TRUE
2. DRILL TAP HOLE	1. MOUNT DRILL CHUCK IN TAILSTOCK SPINDLE 2. INSTALL CENTER DRILL 3. CENTER DRILL PILOT HOLE 4. INSTALL "Q" DRILL 5. DRILL HOLE THROUGH WORKPIECE 6. REMOVE DRILL
3. TAP HOLE 3/8" - 24 NF	1. INSTALL LIVE CENTER IN TAILSTOCK 2. SET LATHE IN BACKGEAR NOTE: THIS IS TO LOCK SPINDLE FROM TURNING AS POWER WILL NOT BE USED 3. INSTALL TAP WRENCH ON TAP SHANK 4. PLACE TAP IN DRILLED HOLE 5. SLIDE TAILSTOCK FORWARD UNTIL CENTER ALMOST MAKES CONTACT WITH TAP 6. LOCK TAILSTOCK 7. TURN TAILSTOCK HANDWHEEL UNTIL CENTER IS SEATED IN TAP SHANK. REFER TO FIG. 1 NOTE: CENTER WILL PROVIDE SUPPORT AND KEEP TAP CENTERED WITH HOLE 8. WITH LEFT HAND TURN TAP WRENCH HOLDER CLOCKWISE NOTE: AT SAME TIME TURN TAILSTOCK HANDWHEEL CLOCKWISE MAINTAINING SLIGHT PRESSURE ON TAP. REFER TO FIG. 1

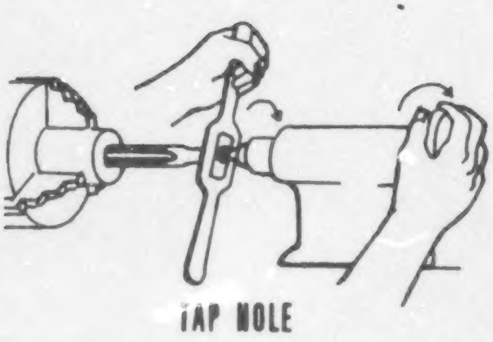


Fig. 1

STEPS	KEY POINTS
	NOTE: CONTINUE LUBRICATION OF TAP AND HOLE
	9. ADVANCE TAP APPROXIMATELY TWO TURNS AND BACK OUT ONE OR ENOUGH TO BREAK CHIPS LOOSE AND CUT SMOOTH THREADS CAUTION: DO NOT FORCE TAP
	10. CONTINUE THREADING TASK UNTIL THREADS HAVE BEEN CUT ABOUT ONE-HALF THE WAY THROUGH
	11. REMOVE CENTER FROM ITS SUPPORTING ROLE
	12. CONTINUE UNTIL THREADS CUT ALL OF THE WAY THROUGH
	13. BACK TAP OUT AND RECHASE TO CLEAN OUT CHIPS
	14. REMOVE TAP
	15. CLEAN TAP AND TAP WRENCH
	16. HOLD FOR NEXT TASK FACING THE TWO RADII

SKETCHES: DRAWING #2A; PART #1, SHANK, RADIUS CUTTER

REFERENCES: REF. #5, PP. 172-173

TASK SHEET

VII-B-1b(TS)

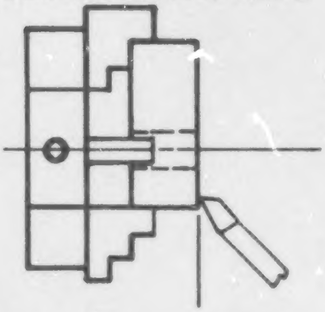
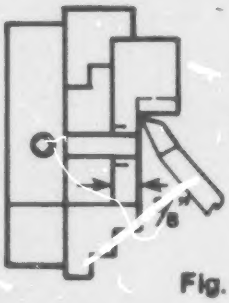
TASK: TURN RADII: 7/8" AND 1 1/2"

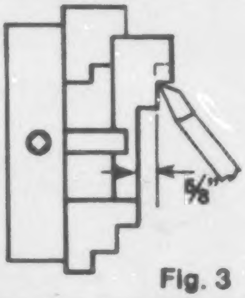
JOB: RADIUS CENTER: PART #1 SHANK

TRADE: MACHINIST

TOOLS AND MATERIALS: ENGINE LATHE, INDEPENDENT CHUCK, R. H. FACING TOOL, 6" RULE, DEPTH MICROMETER, MILL FILE, AND PART #1 AS MACHINED PREVIOUSLY AND CHUCKED TRUE

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP FACING TOOL  Fig. 1	1. INSPECT TOOL FOR SHARPNESS 2. POSITION TOOL AND TOOL HOLDER IN POST NOTE: FACING TOOL IS ON CENTER WITH WORKPIECE 3. ADJUST FACING TOOL SO AS TO CUT SQUARE SHOULDER FOR THE RADII. REFER TO FIG. 1
2. TURN 7/8" RADII  Fig. 2	1. SET FEED AND SPEED NOTE: SET SPEED AT SLOW SPEED 2. FEED TOOL INTO FACE OF WORKPIECE NOTE: DO NOT TAKE HEAVY CUTS DUE TO FORCE AND IMPACT ON TOOL CAUSED BY INTERRUPTION OF CUT 3. TURN 7/8" RADII NOTE: HOLD 3/8" THICKNESS OF WORKPIECE AS PER DRAWING. REFER TO FIG. 2 AND DRAWING #2-A 4. INSPECT DEPTH AND RADIUS
3. TURN 1 1/2" RADII	1. POSITION OF TOOL AND TOOL HOLDER REMAIN THE SAME AS FOR FACING 7/8" RADII 2. MOVE CARRIAGE TOWARD TAILSTOCK UNTIL FACING TOOL CLEARS OUTSIDE FACE OF WORKPIECE NOTE: POSITION WILL BE THE SAME AS IN STARTING TO FACE 7/8" RADII. REFER TO FIG. 1 3. FEED TOOL INTO WORKPIECE NOTE: TAKE LIGHT CUTS AS PER STEP #2

STEPS	KEY POINTS
 Fig. 3	4. FACE 1 1/2" RADIUS NOTE: HOLD 1 1/2" RADIUS LAYOUT LINE 5/8" FROM FACE OF 7/8" RADIUS REFER TO FIG. 3 5. INSPECT RADIUS AND DEPTH 6. BURR ALL EDGES 7. REMOVE FROM MACHINE 8. ROUTE TO MILLING MACHINE

SKETCHES: DRAWING #2-A; PART #1, SHANK, RADIUS CUTTER

REFERENCES: INSTRUCTOR

JOB SHEET
ON
SHAPER

JOB: RADIUS CUTTER

MATERIALS: PART #1: SHANK AS MACHINED IN PREVIOUS TASK

TOOLS AND EQUIPMENT: SHAPER, SHAPER VISE, SHAPER TOOL WITH 1/4" RADIUS, 6" RULE, LAYOUT INK, SCRIBE, SQUARE, PARALLELS, DIAL INDICATOR, AND DEPTH MICROMETER

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 209-225; REF. #4, PP. 291-312; REF. #5, PP. 197-220. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE, AND ON PROCEDURE TO BE FOLLOWED

NOTE: BECAUSE THIS JOB CAN BE PERFORMED ON MORE THAN ONE MACHINE, TASK SHEETS WILL BE WRITTEN ON THE SHAPER WITH AN ALTERNATE TASK WRITTEN ON THE MILLING MACHINE. CHECK WITH INSTRUCTOR AS TO MACHINE TO BE USED AND FOR ANY CHANGE OF PROCEDURE

PROCEDURES AND/OR TASKS:	VIII-A-1(TS)	CHECK SHAPER FOR PROPER OPERATING CONDITION
	*VIII-A-1a(TS)	MACHINE OFFSETS ON SHANK
ALTERNATE TASKS:	IX-A-1(TS)	CHECK HORIZONTAL MILLING MACHINE FOR PROPER OPERATING CONDITION
	*IX-B-1(TS)	MACHINE OFFSETS ON SHANK ROUTE TO BENCH

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS

1. CHECK OPERATING CONDITION OF MACHINE
2. CHECK EACH SETUP FOR ACCURACY AND CORRECTNESS
3. ALL DIMENSIONS HELD TO DRAWING SPECIFICATIONS
4. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS

TASK SHEET

VIII-A-1a(TS)

TASK:	MACHINE OFFSETS ON SHANK
JOB:	RADIUS CUTTER, PART #1: SHANK
TRADE:	MACHINIST
TOOLS AND EQUIPMENT:	SHAPER, SHAPER VISE, TOOL BIT WITH 1/4" RADIUS, 6" RULE, LAYOUT INK, SCRIBE, SQUARE, PARALLEL BARS, DIAL INDICATOR, DEPTH MICROMETER, AND PART #1; SHANK AS MACHINED IN PREVIOUS TASKS

TASK BREAKDOWN:

STEPS	KEY POINTS
1. LAY OUT OFFSETS	1. INK WORKPIECE ON TOP FACE AND THE TWO ADJACENT SIDES NOTE: TOP FACE WILL BE THAT FACE THE RADII ARE MACHINED ON 2. LAY OUT AND SCRIBE A LINE ON THE THREE ABOVE SURFACES 3 3/4" FROM END OF SHANK NOTE: THE END OPPOSITE THE RADIUS END
2. SET UP VISE	1. MOUNT ON SHAPER TABLE NOTE: VISE JAWS POSITIONED PERPENDICULAR TO RAM STROKE 2. TRUE VISE NOTE: USE DIAL INDICATOR TO INSURE TRUE SETUP 3. WIPE VISE BASE AND JAWS CLEAN
3. SET UP WORKPIECE TO MACHINE BOTTOM OFFSET	1. POSITION WORKPIECE IN VISE WITH SHANK PARALLEL TO JAWS AND RADII OFFSETS FACE DOWN NOTE: PLACE WORKPIECE ON PARALLEL BARS SO AS TO PROVIDE CLEARANCE FOR 1/2" FINISH CUT 2. LEVEL WORKPIECE NOTE: A PRECISION LEVEL MAY BE USED BUT THE DIAL INDICATOR WOULD BE MORE ACCURATE NOTE: USE SHIMS TO LEVEL WORKPIECE IF NECESSARY

STEPS	KEY POINTS
	3. TRUE WORKPIECE NOTE: CHECK FROM END TO END AND FRONT EDGE TO BACK EDGE
4. SET SHAPER CONTROLS	1. SET RAM SPEED AT APPROXIMATELY 120 STROKES PER MINUTE 2. SET LENGTH OF STROKE AND POSITION OR RAM NOTE: ALLOW 1/2" CLEARANCE AT END OF EACH STROKE 3. SET TABLE FEED AT .015" PER STROKE NOTE: THIS IS FOR ROUGH MACHINING
5. SET UP TOOL BIT	1. INSPECT TOOL BIT FOR 1/4" RADIUS 2. MOUNT TOOL HOLDER AND TOOL BIT IN TOOL POST NOTE: TOOL BIT SHOULD BE FASTENED IN TOOL HOLDER AS CLOSE TO TOOL POST SCREW AS POSSIBLE 3. POSITION TOOL HOLDER AND TOOL BIT IN VERTICAL POSITION 4. ADJUST TOOL BIT TO WORKPIECE WITH FEELER GAGE 5. SET GRADUATED DIAL ON DOWN FEED SCREW COLLAR AT "0" 6. MOVE TOOL BIT CLEAR OF WORKPIECE
6. MACHINE 1/2" OFFSET NOTE: BOTTOM SIDE	1. SET DEPTH OF CUT FOR .100" 2. ROUGH MACHINE WORKPIECE TO SIZE. HOLD 3 3/4" LENGTH AND 1/2" DEPTH OF CUT NOTE: ALLOW .025" FOR FINISH CUT 3. SET FEED AT .010" PER STROKE 4. FINISH MACHINING TO SIZE. HOLD 3 3/4" LENGTH AND .500" FINISHED DEPTH 5. CUT OFF MACHINE 6. INSPECT WORKPIECE 7. REMOVE WORKPIECE AND BURR 8. WIPE VISE AND PARALLELS
7. MACHINE FIRST SIDE OFFSET	1. SET UP WORKPIECE AS IN STEP #3 2. POSITION WORKPIECE 90° FROM PREVIOUS CUT

STEPS	KEY POINTS
	NOTE: ONE SIDE OF SHANK WILL BE FACE DOWN NOTE: WORKPIECE MUST BE PROTRUDING 9/16" ABOVE VISE JAWS
	3. SET FEED FOR ROUGH CUT AS PER STEP #4
	4. ADJUST TOOL BIT TO WORKPIECE WITH FEELER GAGE NOTE: TOOL POSITION WILL BE THE SAME AS IN STEP #5
	5. MACHINE OFFSET AS PER STEP #6. HOLD 3 3/4" LENGTH AND 15/32" DEPTH
	6. INSPECT AND BURR WORKPIECE
	7. REMOVE WORKPIECE AND CLEAN VISE
8. MACHINE SECOND SIDE OFFSET	1. SET UP WORKPIECE AS PER STEP #7
	2. POSITION WORKPIECE 180° FROM PREVIOUS CUT NOTE: PREVIOUS SIDE CUT WILL BE FACE DOWN
	3. PLACE PARALLEL UNDER WORKPIECE TO SUPPORT AND ELEVATE WORKPIECE NOTE: WORKPIECE MUST PROTRUDE 9/16" ABOVE VISE JAW
	4. MACHINE AS PER STEP #4. HOLD 3 3/4" LENGTH X 15/32"
	5. INSPECT WORKPIECE AND BURR
	6. REMOVE FROM MACHINE
	7. SECURE VISE AND MACHINE
	8. ROUTE TO BENCH FOR LAYOUT OF 3/8" REAMED HOLE

SKETCHES: DRAWING #2A, PART #1: SHANK, RADIUS CUTTER

REFERENCES: REF. #3, PP. 209-225
REF. #4, PP. 291-312
REF. #5, PP. 197-220

JOB SHEET
ON
HORIZONTAL MILLING MACHINE

JOB:	RADIUS CUTTER	
MATERIALS:	PART #1: SHANK AS MACHINED IN PREVIOUS TASKS	
TOOLS AND EQUIPMENT:	HORIZONTAL MILLING MACHINE, MILL VISE, 1/2" END MILL, END MILL HOLDER, 6" RULE, DEPTH MICROMETER, PARALLELS, AND DIAL INDICATOR	
GENERAL INSTRUCTIONS:	BEFORE BEGINNING THIS JOB READ REF. #3, PP. 229-270; REF. #4, PP. 317-354; REF. #5, PP. 223-241. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE	
PROCEDURES AND/OR TASKS:	IX-A-1(TS)	CHECK HORIZONTAL MILLING MACHINE FOR PROPER OPERATING CONDITION
	*IX-B-1(TS)	MACHINE OFFSETS ON SHANK
		ROUTE TO BENCH

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASK

1. CHECK OPERATING CONDITION OF MILLING MACHINE
2. CHECK EACH SETUP FOR ACCURACY AND CORRECTNESS
3. HOLD ALL DIMENSIONS TO SPECIFICATIONS AND TOLERANCE
4. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS

TASK SHEET IX-B-1(TS)

TASK: MACHINE OFFSETS ON SHANK

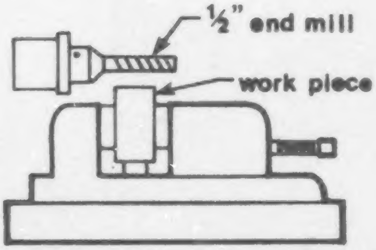
JOB: RADIUS CUTTER, PART #1: SHANK

TRADE: MACHINIST

TOOLS AND MATERIALS: HORIZONTAL MILLING MACHINE, MILL VISE, DIAL INDICATOR, 1/2" END MILL, END MILL HOLDER, 6" RULE, PARALLELS, DEPTH MICROMETER, AND PART #1: SHANK AS MACHINED IN PREVIOUS TASK

TASK BREAKDOWN:

STEPS	KEY POINTS
1. LAY OUT OFFSETS	1. INK WORKPIECE ON TOP FACE AND THE TWO ADJACENT SIDES NOTE: TOP FACE WILL BE THAT FACE THE RADII ARE MACHINED ON 2. LAY OUT AND SCRIBE A LINE ON THE THREE ABOVE SURFACES 3 3/4" FROM END OF SHANK NOTE: THE END OPPOSITE THE RADIUS END
2. SET UP VISE	1. MOUNT VISE ON MILLING MACHINE TABLE NOTE: VISE JAWS POSITIONED PARALLEL TO TABLE NOTE: HANDLE OF VISE DIRECTED AWAY FROM MACHINE 2. TRUE VISE NOTE: USE DIAL INDICATOR TO INDICATE TRUE 3. WIPE VISE BASE AND JAW CLEAN
3. SET UP WORKPIECE TO MACHINE BOTTOM OFFSET	1. POSITION WORKPIECE IN VISE WITH SHANK PARALLEL TO VISE AND RADII OFFSET FACE DOWN NOTE: PLACE WORKPIECE ON PARALLELS TO PROVIDE CLEARANCE FOR 1/2" FINISH CUT 2. LEVEL WORKPIECE NOTE: A PRECISION LEVEL MAY BE USED, ALTHOUGH THE DIAL INDICATOR WOULD BE MORE ACCURATE

STEPS	KEY POINTS
	NOTE: USE SHIMS TO LEVEL WORKPIECE IF NECESSARY 3. TRUE WORKPIECE NOTE: CHECK FROM END TO END AND FRONT EDGE TO BACK EDGE WITH DIAL INDICATOR
4. SET UP 1/2" END MILL	1. SELECT AND INSPECT END MILL FOR SIZE AND CONDITION NOTE: A LONG SINGLE-END END MILL WILL BE REQUIRED 2. MOUNT 1/2" END MILL HOLDER IN SPINDLE 3. MOUNT END MILL IN HOLDER 4. CHECK FOR RUNNING TRUE
5. SET MILLING MACHINE CONTROLS	1. SET SPINDLE SPEED AT 535R.P.M. 2. SET LONGITUDINAL FEED AT .006"
6. POSITION END MILL WITH WORKPIECE 	1. ADJUST TABLE UNTIL END MILL TOUCHES WORKPIECE NOTE: USE FEELER GAGE (PAPER) TO SET HEIGHT CAUTION: DO NOT MAKE ADJUSTMENT WITHOUT CUTTER REVOLVING 2. SET GRADUATED DIAL ON VERTICAL FEED SCREW COLLAR AT "O" 3. CLEAR END MILL FROM WORKPIECE 4. POSITION WORKPIECE SO END MILL WILL MACHINE ACROSS THE COMPLETE FACE. SEE FIGURE 1.
7. MACHINE 1/2" OFFSET NOTE: BOTTOM SIDE	1. MACHINE TO SIZE NOTE: HOLD 3 3/4" LENGTH WITH 1/2" DEPTH NOTE: ALLOW .015" FOR FINISH CUT AND SET FEED AT .003" 2. INSPECT WORKPIECE 3. REMOVE WORKPIECE AND BURR 4. WIPE VISE AND PARALLELS
8. MACHINE OFFSET ON FIRST SIDE	1. POSITION WORKPIECE 90° FROM PREVIOUS CUT NOTE: ONE SIDE OF SHANK WILL BE FACE DOWN NOTE: WORKPIECE MUST BE 9/16" ABOVE TOP OF VISE JAWS

STEPS	KEY POINTS
	2. SET UP WORKPIECE AS IN STEP #3
	3. SET FEED FOR ROUGH CUT NOTE: .006" FEED
	4. ADJUST WORKPIECE TO END MILL AS PER STEP #6
	5. MACHINE OFFSET AS PER STEP #7 NOTE: HOLD 3 3/4" LENGTH AND 15/32" DEPTH
	6. INSPECT AND BURR WORKPIECE
	7. REMOVE WORKPIECE AND CLEAN VISE
9. MACHINE OFFSET ON SECOND SIDE	1. POSITION WORKPIECE 180° FROM SIDE MACHINED IN STEP # 7 NOTE: PREVIOUS SIDE WILL BE FACED DOWN
	2. SET UP WORKPIECE AS PER STEP #3 NOTE: WORKPIECE MUST PROTRUDE ABOVE TOP OF VISE JAWS 9/16"
	3. MACHINE AS PER STEP #7. HOLD 3 3/4" LENGTH AND 15/32" DEPTH NOTE: SHANK WILL MEASURE 9/16" x 1" x 3 3/4"
	4. INSPECT WORKPIECE AND BURR
	5. REMOVE FROM MACHINE
	6. SECURE MACHINE AND TOOLS PROPERLY
	7. ROUTE TO BENCH FOR LAYOUT OF 3/8" REAMED HOLE

SKETCHES: DRAWING #2A, PART #1: SHANK, RADIUS CUTTER

REFERENCES REF. #3, PP. 229-270
REF. #4, PP. 317-354
REF. #5, PP. 223-241

VI-B-1(J)

JOB SHEET
ON
DRILL PRESS

JOB: RADIUS CUTTER

MATERIALS: PART #1: SHANK - AS MACHINED IN PREVIOUS TASK

TOOLS AND EQUIPMENT: DRILL PRESS, DRILL VISE, HEIGHT GAGE, SCRIBE, PRICK PUNCH, BALL PEEN HAMMER, 23/64" DRILL, DRILL CHUCK, 3/8" REAMER

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 95-100; REF. #4, PP. 177-211; REF. #5, PP. 115-138. CHECK WITH INSTRUCTOR UPON COMPLETION OF LAYOUT AND LOCATING CENTER OF HOLE AND BEFORE OPERATING MACHINE

PROCEDURES AND/OR TASK:

VI-A-1(TS) CHECK DRILL PRESS FOR PROPER OPERATING CONDITION

*VI-B-1(TS) LAY OUT, DRILL, AND REAM 3/8" HOLE HOLD FOR ASSEMBLY

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASK.

1. CHECK THE ACCURACY IN LAYOUT AND LOCATION OF HOLE
2. CHECK DRILL PRESS FOR PROPER OPERATING CONDITION
3. CHECK SETUP OF WORKPIECE FOR ACCURACY
4. PROPER SELECTION AND INSPECTION OF TOOLS
5. HOLE DRILLED AND REAMED ACCURATELY AND PERPENDICULAR TO WORKPIECE FACE
6. ALL DIMENSIONS HELD TO SPECIFICATIONS AND TOLERANCES
7. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS

TASK SHEET VI-B-1(TS)

TASK: LAY OUT, DRILL, AND REAM 3/8" HOLE

JOB: RADIUS CUTTER, PART #1: SHANK

TRADE: MACHINIST

TOOLS AND MATERIALS: DRILL PRESS, DRILL VISE, HEIGHT GAGE, SCRIBE, PRICK PUNCH, BALL PEEN HAMMER, CENTER PUNCH, 23/64" DRILL, DRILL CHUCK, 3/8" REAMER, SURFACE PLATE, LAYOUT INK, AND PART #1, SHANK AS MACHINE IN PREVIOUS TASKS.

TASK BREAKDOWN:

STEPS	KEY POINTS
1. LAY OUT CENTER	1. SET VISE ON SURFACE PLATE 2. CLAMP WORKPIECE IN VISE NOTE: MACHINED RADII FACE UP 3. LEVEL WORKPIECE WITH HEIGHT GAGE OR LEVEL NOTE: HEIGHT OF WORKPIECE IS NOT CRITICAL, BUT WORK MUST BE PARALLEL TO SURFACE PLATE 4. SET HEIGHT GAGE SCRIBER POINT WITH THE TOP FACE OF 7/8" RADIUS OFFSET NOTE: 3/8" FROM BOTTOM FACE 5. RAISE HEIGHT GAGE SCRIBER POINT 7/32" AS PER DRAWING NOTE: DISTANCE IS FROM FACE OF 7/8" RADII TO THE CENTER OF 3/8" HOLE 6. SCRIBE CENTER LINE NOTE: CENTER LINE WILL INTERSECT CENTER LINE SCRIBED IN PREVIOUS TASK IV-B-1a(TS) 7. LOCATE CENTER WITH PRICK PUNCH 8. CHECK LAYOUT FOR ACCURACY 9. CENTER PUNCH HOLE CENTER NOTE: LOCATION OF CENTER PUNCH MUST BE ACCURATE
2. SET UP DRILL	1. SELECT AND INSPECT DRILL FOR SIZE AND CONDITION 2. MOUNT DRILL IN SPINDLE NOTE: DRILL MAY BE TAPER SHANK OR STRAIGHT SHANK CHUCK ACCORDINGLY 3. CHECK DRILL FOR RUNNING TRUE

STEPS	KEY POINTS
3. SET UP WORKPIECE	1. MOUNT WORKPIECE IN VISE WITH LAYOUT OF HOLE FACED UP 2. CHECK WORKPIECE FOR LEVEL NOTE: LEVEL, SURFACE GAGE, OR HEIGHT GAGE MAY BE USED 3. ALIGN LAYOUT OF CENTER AND DRILL 4. CLAMP VISE TO TABLE FIRMLY 5. RECHECK ALIGNMENT
4. DRILL HOLE	1. SET SPINDLE SPEED AT APPROXIMATELY 900 R. P. M. 2. SET SPINDLE FEED AT .006" 3. DRILL HOLE THROUGH CAUTION: DO NOT DRILL INTO VISE BASE OR DRILL TABLE NOTE: KEEP DRILL WELL LUBRICATED 4. REMOVE DRILL CAUTION: DO NOT MOVE SETUP, WORKPIECE, OR TABLE
5. REAM HOLE	1. SELECT AND INSPECT REAMER FOR SIZE AND CONDITION 2. MOUNT REAMER IN DRILL SPINDLE 3. CHECK ALIGNMENT OF REAMER AND HOLE NOTE: UNLESS WORKPIECE HAS BEEN MOVED, THE REAMER AND HOLE WILL BE ALIGNED 4. SET SPINDLE SPEED NOTE: APPROXIMATELY 600 R. P. M. OR 2/3 DRILLING SPEED 5. SET POWER FEED AT .015" NOTE: IF HAND FEED IS USED, MAINTAIN A FEED OF TWO TO THREE TIMES AS GREAT AS FOR DRILLING 6. REAM HOLE NOTE: KEEP REAMER WELL LUBRICATED 7. BURR HOLE EDGES 8. INSPECT HOLE NOTE: CHECK FOR ACCURACY AND HOLE FINISH 9. REMOVE REAMER 10. SECURE MACHINE AND STORE ALL TOOLS PROPERLY

STEPS	KEY POINTS
	HOLD FOR ASSEMBLY

SKETCHES: DRAWING #2A, PART #1, SHANK, RADIUS CUTTER

REFERENCES: REF. #3, PP. 95-100
REF. #4, PP. 177-211
REF. #5, PP. 115-138

VII-B-2(J)

JOB SHEET
ON
ENGINE LATHE

JOB:	RADIUS CUTTER
MATERIALS:	PART #2: WORM SCREW - 5/8" X 3 1/4" C. R. ROUND
TOOLS AND EQUIPMENT:	ENGINE LATHE, COLLET ATTACHMENT, 5/8" COLLET, 6" RULE, FACING TOOL, SMALL CENTER DRILL, DRILL CHUCK AND KEY, FACE PLATE, DRIVE DOG, DEAD CENTER, R.H. TURNING TOOL, KNURLING TOOL, 0-1" MICROMETER, THREADING TOOL, CENTER GAGE, SCREW PITCH GAGE OR THREAD MICROMETER, 5/8" RADIUS FORMING TOOL, AND 1/4" RADIUS FORMING TOOL
GENERAL INSTRUCTIONS:	BEFORE BEGINNING THIS JOB READ REF. #3, PP. 135-184; REF. #4, PP. 217-282; REF #5, PP. 141-182. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE
PROCEDURES AND/OR TASKS:	VII-A-1(TS) CHECK ENGINE LATHE FOR PROPER OPERATING CONDITION *VII-B-2(TS) MACHINE WORM SCREW HOLD FOR ASSEMBLY
CHECK POINTS:	STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS. 1. CHECK OPERATING CONDITION OF MACHINE 2. CHECK EACH SETUP FOR CORRECTNESS AND ACCURACY 3. HOLD ALL DIMENSIONS TO SPECIFICATIONS 4. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS 5. OBSERVANCE OF ALL RULES AND REGULATIONS

TASK SHEET

VII-B-2(TS)

TASK: MACHINE WORM SCREW

JOB: RADIUS CUTTER, PART #2: WORM SCREW

TRADE: MACHINIST

TOOLS AND MATERIALS: ENGINE LATHE, COLLET ATTACHMENT, 5/8" COLLET, 6" RULE, FACING TOOL, NO. 2 CENTER DRILL, DRILL CHUCK AND KEY, DEAD CENTER, R.H. TURNING TOOL, KNURLING TOOL, CENTER GAGE, SCREW PITCH GAGE OR THREAD MICROMETER, FACE PLATE, DRIVE DOG, 0-1" MICROMETER, 5/8" RADIUS FORMING TOOL, 1/4" RADIUS FORMING TOOL, AND MATERIAL FOR PART #2: 5/8" X 3 1/4" C.R. ROUND

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP WORKPIECE	1. MOUNT COLLET ATTACHMENT 2. INSTALL 5/8" COLLET 3. CHUCK WORKPIECE NOTE: WORKPIECE TO EXTEND OUT 5/8"
2. FACE AND CENTER DRILL ENDS	1. SET UP FACING TOOL 2. FACE END FOR CLEANUP ONLY 3. INSTALL DRILL CHUCK IN TAILSTOCK SPINDLE 4. INSTALL NO. 2 CENTERDRILL 5. CENTER DRILL END 6. REVERSE ENDS NOTE: WORKPIECE TO EXTEND OUT 1 5/8" 7. FACE TO LENGTH NOTE: HOLD 3" LENGTH 8. CENTERDRILL END
3. KNURL WORKPIECE	1. REMOVE DRILL CHUCK 2. INSERT DEAD CENTER 3. MOVE DEAD CENTER UP TO WORKPIECE NOTE: DO NOT APPLY HEAVY PRESSURE ON CENTER AND KEEP WELL LUBRICATED 4. SET UP KNURLING TOOL 5. KNURL WORKPIECE NOTE: HOLD APPROXIMATELY 1 3/8" KNURL LENGTH

STEPS	KEY POINTS
	6. REMOVE WORKPIECE FROM COLLET
4. SET UP WORKPIECE BETWEEN CENTERS	1. MOUNT FACE PLATE ON SPINDLE
	2. FASTEN LATHE DOG TO WORKPIECE NOTE: MOUNT ON KNURLED PART OF WORKPIECE CAUTION: PROTECT KNURLS WITH SHIM STOCK
	3. CHECK ALIGNMENT BETWEEN LIVE CENTER AND DEAD CENTER NOTE: ALIGNMENT MUST BE MADE IF THE CENTERS ARE MISALIGNED
	4. MOUNT WORKPIECE BETWEEN THE TWO CENTERS AND TIGHTEN TAILSTOCK HAND WHEEL NOTE: LUBRICATE CENTER CAUTION: DO NOT TIGHTEN TAILSTOCK TOO MUCH AS HEAT EXPANSION WILL CAUSE CENTERS TO BURN
5. TURN DIAMETERS	1. SET UP TURNING TOOL NOTE: TOOL MUST BE GROUND AND POSITIONED TO PROVIDE SQUARE SHOULDER
	2. TURN WORKPIECE TO .374" DIAMETER NOTE: HOLD 1 13/16" LENGTH FROM END
	3. TURN WORKPIECE TO .250" DIAMETER NOTE: HOLD 5/16" FROM END
	4. REMOVE TURNING TOOL
6. TURN 3/8" -16 N.C. THREAD	1. SELECT AND INSPECT THREADING TOOL
	2. SET COMPOUND REST AT 29° NOTE: KNOB WILL BE TOWARD TAILSTOCK
	3. POSITION THREADING TOOL NOTE: HOLD TOOL ON CENTER AND PERPENDICULAR TO WORKPIECE
	4. SET CROSS FEED AND COMPOUND REST COLLARS ON "O" NOTE: POINT OF TOOL IN CONTACT WITH WORKPIECE
	5. CLEAR TOOL TO THE RIGHT OF WORKPIECE

STEPS	KEY POINTS
	CAUTION: DO NOT RUN TOOL INTO DEAD CENTER 6. SET SPINDLE SPEED AT SLOW R. P. M. 7. SET THREAD PITCH ON LEAD SCREW FOR 16 T. P. I. 8. LAYOUT EXTREMITIES OF THREAD NOTE: THE BEGINNING OF THREAD IS 3 / 4" FROM THE END OF THE WORKPIECE, AND END OF THREAD IS 1 3 / 8" FROM END OF WORKPIECE 9. CUT THREADS TO DEPTH NOTE: HOLD 5/8" THREAD LENGTH NOTE: THREADS MUST BE PRECISE AS THE HOBS ON THE TOOL HOLDER MUST FIT THEM 10. BURR THREADS NOTE: USE THREE CORNERED FILE 11. INSPECT NOTE: THREAD MICROMETER OR MICROMETER AND THREE WIRE METHOD WOULD BE MOST ACCURATE
7. TURN 1/4" - 20 N. C. THREAD	FOLLOW SAME PROCEDURE AS STEP #6
8. TURN 1/16" X 45° CHAMFER	1. SET COMPOUND REST AT 45° NOTE: KNOB WILL BE TOWARD HEADSTOCK 2. POSITION TOOL NOTE: THREADING TOOL MAY BE USED 3. TURN CHAMFER NOTE: HOLD 1/16" X 45°
9. FORM 5/8" SPHERICAL RADIUS ON END	1. SET UP COLLET ATTACHMENT 2. INSTALL 5/8" COLLET 3. MOUNT WORKPIECE IN COLLET NOTE: EXTEND MATERIAL OUT ONLY ENOUGH TO CLEAR 5/8" FORMING TOOL 4. SET UP 5/8" FORMING TOOL 5. FORM 5/8" SPHERICAL RADIUS ON END NOTE: DO NOT REMOVE CENTER DRILLED HOLE 6. BURR EDGES 7. REMOVE WORKPIECE FROM COLLET

STEPS	KEY POINTS
10. FORM 1/4" SPHERICAL RADIUS ON END	1. MOUNT WORKPIECE IN COLLET NOTE: CHUCK ON KNURLED PART 2. SET UP 1/4" RADIUS FORMING TOOL 3. FORM 1/4" RADIUS NOTE: DO NOT REMOVE CENTER DRILLED HOLD 4. BURR EDGES 5. REMOVE FROM MACHINE 6. SECURE MACHINE AND PROPERLY STORE ALL TOOLS HOLD FOR ASSEMBLY

SKETCHES: DRAWING #2B; PART #2; WORM SCREW, RADIUS CUTTER

REFERENCES: REF. #3, PP. 135-184
REF. #4, PP. 217-282
REF. #5, PP. 141-182

VII-B-3(J)

JOB SHEET
ON
ENGINE LATHE

JOB:	RADIUS CUTTER	
MATERIALS:	PART #4: 9/16" X 1 3/4" COLD ROLL ROUND	
TOOLS AND EQUIPMENT:	ENGINE LATHE, COLLET ATTACHMENT, 9/16" COLLET, FACING TOOL, #2 CENTER DRILL, DRILL CHUCK, LIVE CENTER, TURNING TOOL, 6" RULE, 0-1" MICROMETER, SCREW PITCH GAGE, CENTER GAGE, AND 60° THREADING TOOL	
GENERAL INSTRUCTIONS:	BEFORE BEGINNING THIS JOB READ REF. #3, PP. 135-184; REF. #4, PP. 217-282; REF. #5, PP. 141-182. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE	
PROCEDURES AND/OR TASKS:	VII-A-1(TS)	CHECK ENGINE LATHE FOR PROPER OPERATING CONDITION
	*VII-B-3(TS)	MACHINE SWIVEL SCREW ROUTE TO MILLING MACHINE
CHECK POINTS:	STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS	

1. CHECK OPERATING CONDITION OF MACHINE
2. CHECK EACH SETUP FOR CORRECTNESS AND ACCURACY
3. HOLD ALL DIMENSIONS TO SPECIFICATIONS
4. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS
5. OBSERVANCE OF ALL SAFETY RULES AND REGULATIONS

TASK SHEET VII-B-3(TS)

TASK:	MACHINE PART #4: SWIVEL SCREW
JOB:	RADIUS CUTTER
TRADE:	MACHINIST
TOOLS AND MATERIALS:	ENGINE LATHE, COLLET ATTACHMENT, 9/16" COLLET, FACING TOOL, #2 CENTERDRILL, DRILL CHUCK, LIVE CENTER, TURNING TOOL, 6" RULE, 0-1" MICROMETER, SCREW PITCH GAGE OR THREAD MICROMETER, CENTER GAGE, 60° THREADING TOOL, AND MATERIAL FOR PART #4: 9/16" X 1 3/4" C.R. ROUND

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP WORKPIECE	1. MOUNT COLLET ATTACHMENT 2. INSTALL 9/16" COLLET 3. CHUCK WORKPIECE NOTE: 1/2" EXTENDED OUT FROM COLLET
2. FACE AND CENTERDRILL END OF WORKPIECE	1. SET UP FACING TOOL 2. FACE END FOR CLEANUP ONLY 3. INSTALL DRILL CHUCK IN TAILSTOCK SPINDLE 4. INSTALL NO. 2 CENTERDRILL 5. CENTERDRILL END OF WORKPIECE
3. TURN 3/8" DIAMETER	1. LOOSEN COLLET 2. SLIDE WORKPIECE OUT NOTE: WORKPIECE EXTENDED APPROXIMATELY 1 1/2" OR SUFFICIENT TO CLEAR 1 1/4" IN TURNING 3/8" DIAMETER 3. SET UP DEAD CENTER IN TAILSTOCK SPINDLE 4. SLIDE TAILSTOCK TOWARD WORKPIECE UNTIL CENTER IS SEATED IN WORKPIECE NOTE: LUBRICATE CENTER 5. SET UP TURNING TOOL NOTE: TOOL MUST BE GROUND AND POSITIONED TO PROVIDE SQUARE SHOULDER ON SCREW HEAD 6. SET SPINDLE SPEED

STEPS	KEY POINTS
	7. SET FEED
	8. TURN WORKPIECE TO .374" DIAMETER NOTE: HOLD 1 1/4 " LENGTH
	9. BURR EDGE ON SCREW HEAD
	10. INSPECT
4. TURN CHAMFER	1. SET COMPOUND REST AT 45° NOTE: TOOL WILL REQUIRE REPOSITIONING
	2. MACHINE CHAMFER TO SIZE NOTE: HOLD 1/16" X 45°
	3. BURR EDGES
5. TURN 3/8" - 24 NF THREAD	1. SELECT AND INSPECT THREADING TOOL
	2. SET COMPOUND REST AT 29° NOTE: KNOB WILL BE TOWARD TAILSTOCK
	3. POSITION THREADING TOOL NOTE: HOLD TOOL ON CENTER AND PERPENDICULAR TO WORKPIECE
	4. SET SPINDLE SPEED AT SLOW R. P. M.
	5. SET THREAD PITCH ON LEAD SCREW FOR 24 T. P. I.
	6. SET CROSS FEED AND COMPOUND REST COLLARS ON "O" AS PER VII-B-2(TS) STEP #6 NOTE: POINT OF TOOL IN CONTACT WITH WORKPIECE
	7. CUT THREADS TO FINISHED SIZE NOTE: HOLD 3/4" THREAD
	8. BURR THREADS WITH THREE-CORNER FILE
	9. INSPECT THREADS
	10. REMOVE WORKPIECE FORM COLLET
6. FACE SCREW HEAD	1. REMOVE 9/16" COLLET
	2. INSTALL 3/8" COLLET
	3. SET UP WORKPIECE NOTE: CHUCK CLOSE TO SCREW HEAD
	4. FACE SCREW HEAD TO SIZE NOTE: HOLD 3/16" HEAD LENGTH AND 1 7/16" OVERALL LENGTH
	5. BURR ALL EDGES
	6. INSPECT
	7. SECURE MACHINE AND ALL TOOLS PROPERLY

STEPS	KEY POINTS
	ROUTE TO MILLING MACHINE

SKETCHES: DRAWING #2B: PART #4, SWIVEL SCREW, RADIUS CUTTER

REFERENCES: REF. #3, PP. 135-184
REF. #4, PP. 217-282
REF. #5, PP. 141-182

IX-B-2(J)

JOB SHEET
ON
HORIZONTAL MILLING MACHINE

JOB:	RADIUS CUTTER
MATERIALS:	PART #4: SWIVEL SCREW - AS MACHINED IN PREVIOUS TASK ON THE ENGINE LATHE
TOOLS AND EQUIPMENT:	HORIZONTAL MILLING MACHINE, MILL VISE, ARBOR AND SPACING COLLARS, 1/16" SLITTING SAW, V-BLOCK, AND 6" RULE, PARALLELS, AND MILL FILE
GENERAL INSTRUCTIONS:	BEFORE BEGINNING THIS JOB READ REF. #3, PP. 229-270; REF. #4, PP. 317-354; REF. #5, PP. 223-241. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE

PROCEDURES AND/OR TASKS:	IX-A-1(TS)	CHECK MILLING MACHINE FOR PROPER OPERATING CONDITION
	*IX-B-2(TS)	SET UP AND MILL 1/16" X 1/16" SLOT HOLD FOR ASSEMBLY

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS

1. CHECK OPERATING CONDITION OF MACHINE
2. CHECK THE ACCURACY OF WORK SETUP
3. HOLD ALL DIMENSIONS TO SPECIFICATIONS
4. OBSERVANCE OF ALL SAFETY RULES AND REGULATIONS
5. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS

TASK SHEET

IX-B-2(TS)

TASK: SET UP AND MILL 1/16" X 1/16" SLOT

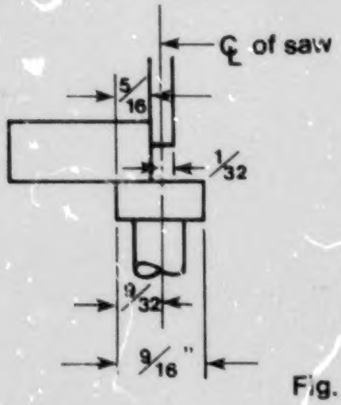
JOB: RADIUS CUTTER, PART #4: SWIVEL SCREW

TRADE: MACHINIST

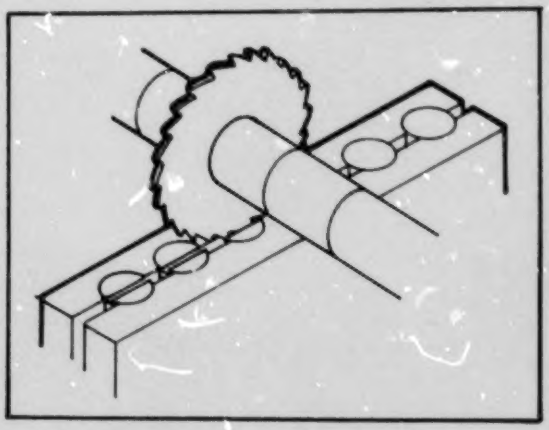
TOOLS AND MATERIALS: HORIZONTAL MILLING MACHINE, MILL VISE, 6" RULE, ARBOR, SPACING COLLARS, MILL FILE, 1/16" SLITTING SAW, V-BLOCKS AND CLAMP, PARALLELS, AND PART #4 AS MACHINED ON THE ENGINE LATHE IN PREVIOUS TASK

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP VISE	1. MOUNT VISE ON MILL TABLE NOTE: JAWS WILL BE PARALLEL TO SLITTING SAW AND PERPENDICULAR TO ARBOR NOTE: INDICATING OF VISE TRUE IS NOT NECESSARY 2. WIPE VISE JAWS AND BASE CLEAN 3. TIGHTEN VISE TO MILL TABLE
2. SET UP WORKPIECE	1. PLACE PARALLELS IN VISE BASE NOTE: V-BLOCK MUST BE HIGH ENOUGH FOR V-BLOCK CLAMP TO CLEAR VISE JAWS IN CLAMPING WORKPIECE TO V-BLOCK 2. CLAMP WORKPIECE TO V-BLOCK NOTE: USE SHIM PROTECTION BETWEEN V-BLOCK CLAMP SCREW AND WORKPIECE NOTE: POSITION UNDERSIDE OF SWIVEL SCREW HEAD ON TOP OF V-BLOCK 3. TIGHTEN CLAMP SCREW 4. SET V-BLOCK ON PARALLELS 5. TIGHTEN VISE FIRMLY
3. SET UP MACHINE	1. SET SPEED 2. SET FEED 3. SET UP ARBOR 4. INSTALL SLITTING SAW NOTE: FOR CONVENTIONAL MILLING 5. POSITION ARBOR SUPPORT

STEPS	KEY POINTS
4. MACHINE SLOT  Fig. 1	1. CENTER CUTTER WITH WORKPIECE NOTE: MEASURE 5/16" FROM OUTSIDE EDGE OF SCREW HEAD TO SIDE OF CUTTER AS IN FIGURE 1 2. SET MACHINE FOR DEPTH OF CUT NOTE: MAY REQUIRE TWO CUTS 3. MACHINE SLOT TO DEPTH NOTE: HOLD 1/16" DEPTH 4. BURR EDGES OF SLOT 5. REMOVE AND INSPECT 6. SECURE MACHINE AND PROPERLY STORE ALL TOOLS 7. HOLD FOR ASSEMBLY

NOTE: WHERE MORE THAN ONE SWIVEL SCREW IS TO BE SLOTTED, THE FIXTURE BELOW WOULD BE USED TO ELIMINATE SETUP TIME



SKETCHES: DRAWING #2B: PART #4, SWIVEL SCREW, RADIUS CUTTER

REFERENCES:
REF. #3, PP. 229-270
REF. #4, PP. 317-354
REF. #5, PP. 223-241

JOB SHEET
ON
BENCH

IV-B-2(J)

JOB:	RADIUS CUTTER	
MATERIALS:	PART #3, TOOL HOLDER, 2½" DIAMETER x 1 3/4" LENGTH C.R. ROUND	
TOOLS AND EQUIPMENT:	LAYOUT INK, SCRIBE, COMBINATION SQUARE, CENTER HEAD, 6" RULE, LAYOUT BENCH. BALL PEEN HAMMER, PRICK PUNCH, ARBOR PRESS, SPECIAL BROACH, VISE, ¼-20-NC TAP, TAP WRENCH, AND FILE	
GENERAL INSTRUCTIONS:	BEFORE BEGINNING THIS JOB READ REF. #3, PP. 57-65; REF. #5, PP. 53-63; REF. #6, PP. 70-92. CHECK WITH THE INSTRUCTOR UPON COMPLETION OF LAYOUT	
PROCEDURES AND/OR TASK:	IV-B-1(TS)	OBTAIN 2½" x 1 3/4" C. R. ROUND FROM SUPPLY ROOM
	*IV-B-2(TS)	LAY OUT CENTER FOR 3/8" REAMED HOLE ROUTE TO ENGINE LATHE
	*IV-B-2a(TS)	LAY OUT CENTER FOR TAPPED HOLE AND SQUARE HOLE ROUTE TO DRILL PRESS
	*IV-B-2b(TS)	SET UP AND BROACH ¼" SQUARE HOLE
	IV-B-2c(TS)	TAP ¼"-20-NC THREAD ROUTE TO ENGINE LATHE
CHECK POINTS:	STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS	

1. CHECK FOR PROPER SELECTION AND CONDITION OF TOOLS
2. SPECIAL BROACH TOOL GROUND PROPERLY
3. SAFETY PROCEDURE TO BE OBSERVED IN BROACHING HOLE
4. MAINTAIN CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS

TASK SHEET

IV-B-2(TS)

TASK:	LAY OUT CENTER FOR 3/8" REAMED HOLE
JOB:	RADIUS CUTTER
TRADE:	MACHINIST
TOOLS AND MATERIALS:	LAYOUT INK, SCRIBE, COMBINATION SQUARE, CENTER HEAD, 6" RULE, LAYOUT TABLE, BALL PEEN HAMMER, PRICK PUNCH, AND MATERIAL FOR PART #3, 2½" x 1 3/4" C. R. ROUND

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP WORKPIECE	1. BURR EDGES BEFORE MAKING LAYOUT 2. INK ONE END OF WORKPIECE 3. LAY WORKPIECE ON LAYOUT TABLE NOTE: PLACE IN HORIZONTAL POSITION
2. LAY OUT CENTER FOR 1 11/16" DIAMETER NOTE: THIS IS THE REFERENCE CENTER FOR HOB HOLE	1. SET HEIGHT GAGE SCRIBE AT 1½" 2. SCRIBE HORIZONTAL LINE ACROSS END OF WORKPIECE NOTE: SUPPORT WORKPIECE WITH HANDS, CLAMP, OR BLOCKS 3. REVOLVE WORKPIECE UNTIL SCRIBED LINE IS IN PERPENDICULAR POSITION NOTE: THE HEIGHT GAGE MAY BE USED TO CHECK POSITION OF LINE 4. SET HEIGHT GAGE AT 1¼" 5. SCRIBE LINE ACROSS FACE OF WORKPIECE NOTE: THE SCRIBED LINE WILL BE 1¼" FROM THE LAYOUT TABLE AND PERPENDICULAR TO PREVIOUS SCRIBED LINES
3. INSPECT LAYOUT	1. CHECK CENTER LINES FOR CORRECT LOCATION 2. CHECK CENTER LINES FOR PERPENDICULARITY TO EACH OTHER 3. LOCATION CENTER WITH PRICK PUNCH NOTE: BE SURE PUNCH MARK IS IN THE CENTER OF LAYOUT
4. SCRIBE 1 11/16" CIRCLE NOTE: THIS WILL BE THE REFERENCE CIRCLE FOR THE HOB	1. POSITION WORKPIECE UPRIGHT ON LAYOUT TABLE NOTE: CENTER FOR 3/8" REAMED HOLE WILL BE UP

STEPS	KEY POINTS
	2. SET DIVIDERS ON 27/32" NOTE: THIS IS THE RADIUS FOR THE 1 11/16" CIRCLE
	3. WITH ONE LEG OF THE DIVIDER IN LOCATED CENTER SCRIBE 1 11/16" CIRCLE
	4. CHECK CIRCLE FOR ACCURACY ROUTE TO ENGINE LATHE

SKETCHES: DRAWING #2C, PART #3, TOOL HOLDER, RADIUS CUTTER

REFERENCE: INSTRUCTOR

VII-B-4(J)

JOB SHEET
ON
ENGINE LATHE

JOB: RADIUS CUTTER

MATERIALS: PART #3, 2 1/2" DIAMETER x 1 3/4" LENGTH C. R. ROUND

TOOLS AND EQUIPMENT: 6" RULE, ENGINE LATHE, INDEPENDENT CHUCK, FACING TOOL, CENTER DRILL, DRILL CHUCK, TURNING TOOL, 23/64" DRILL, 3/8" REAMER, DEPTH MICROMETER, AND 1-2" MICROMETER

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 57-65, 135-204; REF. #4, PP. 217-283; REF. #5, PP. 55-63, 141-194. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE

PROCEDURES AND/OR TASKS:

VII-A-1(TS)	CHECK ENGINE LATHE FOR PROPER OPERATING CONDITION
*VII-B-4(TS)	ROUGH TURN BASE OF TOOL HOLDER, DRILL AND REAM 3/8" HOLE NOTE: ROUTE TO VERTICAL MILLING MACHINE AND DRILL PRESS BEFORE COMPLETING LATHE OPERATIONS
*VII-B-4a(TS)	FINISH TURN TOOL HOLDER BASE TO 1 11/16" DIAMETER
*VII-B-4b(TS)	TURN 1/4" x 1 7/16" DIAMETER
*VII-B-4c(TS)	SET UP AND TURN 2.2375" DIAMETER
*VII-B-4d(TS)	SET UP SPECIAL FIXTURE AND MOUNT WORKPIECE
*VII-B-4e(TS)	TURN HOB HOLD FOR ASSEMBLY

ROUTE TO VERTICAL MILLING MACHINE

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASK

1. CHECK THE OPERATING CONDITION OF THE LATHE
2. CHECK FOR PROPER SETUP OF WORKPIECE
3. ALL DIMENSIONS HELD TO DRAWING SPECIFICATIONS
4. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS
5. OBSERVANCE OF ALL SAFETY RULES AND REGULATIONS

TASK SHEET VII-B-4(TS)

TASK:	ROUGH TURN BASE OF TOOL HOLDER, DRILL AND REAM 3/8" HOLE
JOB:	RADIUS CUTTER
TRADE:	MACHINIST
TOOLS AND MATERIALS:	ENGINE LATHE, INDEPENDENT CHUCK, FACING TOOL, TURNING TOOL, DRILL CHUCK, CENTER DRILL, 23/64" DRILL, 3/8" REAMER, 6" RULE, AND MILL FILE

TASK BREAKDOWN:

STEPS	KEY POINTS
1. CHUCK WORKPIECE	1. INSTALL INDEPENDENT CHUCK
	2. MOUNT WORKPIECE IN CHUCK NOTE: WORKPIECE TO EXTEND OUT 3/4" FROM CHUCK
	3. ADJUST CHUCK JAWS UNTIL CENTER PUNCHED HOLE IS NEARLY TRUE
	4. PLACE SCRIBER IN TOOL POST TO TRUE WORKPIECE NOTE: DEAD CENTER OR WIGGLER PLACED IN DRILL CHUCK IN TAILSTOCK CAN BE USED ALSO NOTE: SCRIBER POINT MUST BE ON CENTER
	5. ADJUST CHUCK JAWS UNTIL PUNCHED HOLE IS TRUE WITH SCRIBER POINT
	6. TIGHTEN CHUCK JAWS FIRMLY
2. FACE AND CENTER DRILL WORKPIECE	1. SET UP AND FACE FOR CLEANUP ONLY
	2. SET UP DRILL CHUCK AND CENTER DRILL
	3. CENTER DRILL FOR PILOT ONLY
	4. REMOVE CENTER DRILL
3. ROUGH TURN TOOL HOLDER BASE	1. SET UP TURNING TOOL
	2. ROUGH TURN DIAMETER NOTE: HOLD 1 23/64" x 11/16" LENGTH
	3. BURR EDGES
4. DRILL AND REAM 3/8" HOLE	1. SELECT AND INSPECT DRILL
	2. SET UP 23/64" DRILL
	3. DRILL HOLE NOTE: HOLD 1" DEEP

STEPS	KEY POINTS
	4. SET SPINDLE SPEED NOTE: APPROXIMATELY 1/2 DRILLING SPEED
	5. SELECT AND INSPECT REAMER
	6. MOUNT REAMER IN CHUCK NOTE: REAMER MAY BE MOUNTED DIRECTLY IN TAILSTOCK SPINDLE
	7. REAM HOLE TO .375" DIAMETER NOTE: HOLD 1" DEPTH
	8. BURR WORKPIECE
	9. ROUTE TO MILLING MACHINE

SKETCHES: DRAWING NO. 2-C, PART #3, TOOL HOLDER, RADIUS CUTTER

REFERENCES: REF. #3, PP. 135-204
REF. #4, PP. 217-283
REF. #5, PP. 141-194

IX-B-3(J)

JOB SHEET
ON
VERTICAL MILLING MACHINE

JOB: RADIUS CUTTER

MATERIALS PART #3, TOOL HOLDER, 2 1/2" DIAMETER x 1 3/4" LENGTH C. R. ROUND AS MACHINED IN PREVIOUS TASKS

TOOLS AND EQUIPMENT: VERTICAL MILLING MACHINE, FINGER CLAMP AND HEEL BLOCK, 11/16" PARALLEL BAR, STOP BLOCKS, DIAL INDICATOR, 1 1/2" END MILL WITH SPHERICAL RADIUS, END MILL HOLDER, 1" END MILL WITH SPHERICAL RADIUS AND 1" END MILL (NOTE: NO RADIUS)

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 229-283; REF. #4, PP. 317-405; REF. #5, PP. 223-298. CHECK WITH THE INSTRUCTOR BEFORE OPERATING MACHINE AND ON COMPLETION OF SETUP

PROCEDURES AND/OR TASKS:

IX-A-1(TS)	CHECK MILLING MACHINE FOR PROPER OPERATING CONDITIONS
*IX-B-3(TS)	SET UP AND MILL 3/4" SPHERICAL RADIUS
*IX-B-3a(TS)	SET UP AND MILL 1/2" SPHERICAL RADIUS
*IX-B-3b(TS)	SET UP AND MILL HOLDER TO FINISHED HEIGHT
	ROUTE TO BENCH

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS

1. CHECK OPERATING CONDITION OF MILLING MACHINE
2. BEFORE MILLING RADII BE SURE SETUP IS MADE PROPERLY AND CORRECTLY
3. MAKE SURE ALL SETUPS ARE PROPERLY SECURED
4. HOLD ALL DIMENSIONS TO DRAWING SPECIFICATIONS
5. MAINTAIN CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS
6. OBSERVANCE OF ALL SAFETY RULES

TASK SHEET

IX-B-3(TS)

TASK:	SET UP AND MILL 3/4" SPHERICAL RADIUS
JOB:	RADIUS CUTTER
TRADE:	MACHINIST
TOOLS AND MATERIALS:	VERTICAL MILLING MACHINE, 1 1/2" END MILL WITH SPHERICAL RADIUS, END MILL HOLDER, DIAL INDICATOR, HEEL BLOCK, 11/16" PARALLEL BAR, FINGER CLAMP, STOP BLOCKS, AND PART #3, TOOL HOLDER, AS MACHINED IN PREVIOUS TASKS

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP WORKPIECE ON MILL TABLE	1. WIPE MILL TABLE CLEAN 2. POSITION WORKPIECE ON THE MILL TABLE NOTE: SMALL DIAMETER WILL BE DOWN WITH OFFSET TOWARD FRONT OF MACHINE AND SQUARE WITH IT 3. PLACE 11/16" PARALLEL BAR UNDER STEP OF WORKPIECE 4. POSITION FINGER CLAMP ON TOP OF WORKPIECE CAUTION: DO NOT LET FINGER CLAMP EXTEND TO WHERE CUTTER WILL PASS NOTE: BE SURE CLAMP BOLT IS CLOSE TO WORKPIECE AND HEEL IS LOCATED AT BACK OF CLAMP. REFER TO FIG. 1 FOR SET UP 5. CLAMP FINGER CLAMP EXTREMELY TIGHT 6. SET UP TWO STOP BLOCKS AS SEEN IN FIG. 1 7. CLAMP OR BOLT STOP BLOCKS TO TABLE AND WORKPIECE NOTE: STOP BLOCKS WILL HELP PREVENT WORKPIECE FROM TURNING
2. SET UP MILLING CUTTER	1. SELECT AND INSPECT 1 1/2" SPHERICAL RADIUS END MILL 2. SET UP END MILL AND HOLDER 3. CHECK END MILL FOR RUNNING TRUE

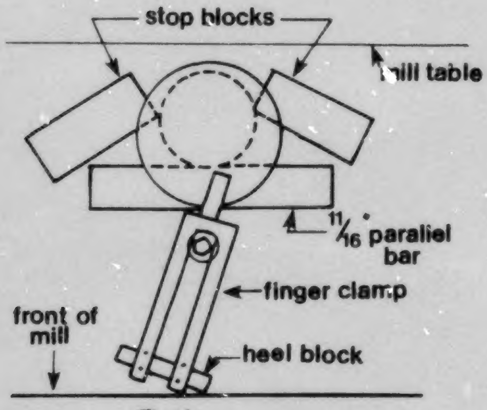


Fig.1

STEPS	KEY POINTS
3. SET UP MACHINE	1. SET FEED DIRECTION FOR CONVENTIONAL MILLING
	2. SET FEED RATE AT .004"
	3. SET SPINDLE SPEED AT 165 R.P.M.
4. MACHINE RADIUS	1. ADJUST TABLE VERTICAL FEED UNTIL BOTTOM OF END MILL IS EXACTLY 11/16" ABOVE TABLE NOTE: CHECK WITH INSTRUCTOR
	2. LOCK VERTICAL FEED
	3. MOVE CROSS FEED AND LONGITUDINAL FEED UNTIL CUTTER TOUCHES THE SIDE OF WORKPIECE
	4. SET CROSS FEED DIAL ON "0"
	5. CLEAR WORKPIECE FROM CUTTER
	6. FEED IN .050" AND LOCK CROSS FEED
	7. TURN MACHINE ON
	8. MAKE FIRST CUT
	9. CLEAR WORKPIECE FROM CUTTER
	10. FEED IN .050" AND MAKE CUT
	11. FINISH MACHINE RADIUS TO SIZE NOTE: HOLD 3/4" FROM REFERENCE SIDE OF WORKPIECE AND 11/16" FROM BOTTOM AS SPECIFIED. REFER TO FIG. 2
	12. BURR EDGES
	13. INSPECT FOR SPECIFIED SIZE
	14. HOLD FOR NEXT OPERATION

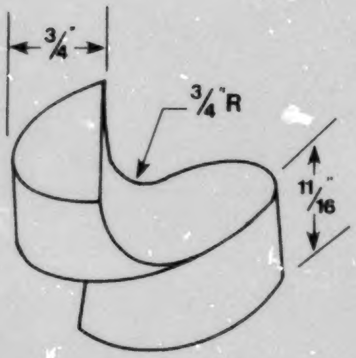


Fig. 2

SKETCHES: DRAWING #2, PART #3, TOOL HOLDER, RADIUS CUTTER

REFERENCES: INSTRUCTOR

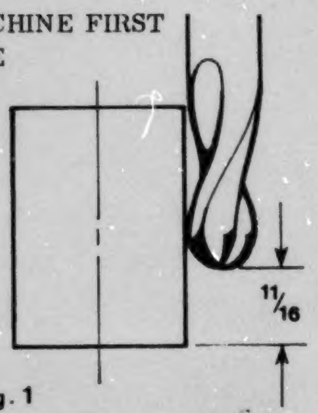
117

TASK SHEET

IX-B-3a(TS)

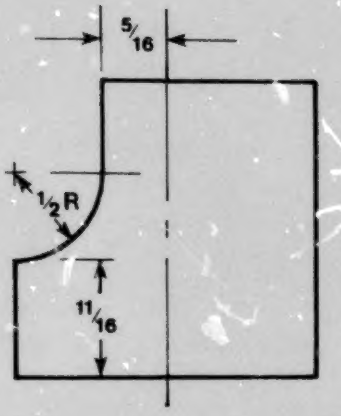
TASK:	SET UP AND MILL 1/2" SPHERICAL RADIUS
JOB:	RADIUS CUTTER: PART #3, TOOL HOLDER
TRADE:	MACHINIST
TOOLS AND MATERIALS:	VERTICAL MILLING MACHINE, 1" END MILL WITH SPHERICAL RADIUS, END MILL HOLDER, PARALLEL BAR, FINGER CLAMP, TWO STEP BLOCKS, HEEL BLOCK, 0-1" MICROMETER, AND TOOL HOLDER AS MACHINED IN PREVIOUS TASK IX-B-3(TS)

TASK BREAKDOWN:

STEPS	KEY POINTS
1. LAY OUT 5/8" DIMENSION NOTE: CENTER LINE AS REFERENCE	1. CENTER LINE SHOULD BE SCRIBED IN CORRECT POSITION AS LAID OUT IN PREVIOUS TASK IV-B-2(TS) NOTE: SHOULD CENTER LINE BE WRONG OR NOT CLEARLY VISIBLE, LAY OUT CENTER LINE AS PER DRAWING 2. SCRIBE TWO LINES 5/16" FROM CENTER LINES
2. SET UP WORKPIECE ON MILL TABLE	REFER TO PREVIOUS TASK IX-B-3(TS) NOTE: SETUP WILL BE THE SAME AND SHOULD NOT HAVE BEEN REMOVED NOTE: ALL MACHINING WILL BE PERFORMED USING THE CROSS FEED
3. SET UP MACHINE	1. INSPECT AND INSTALL 1" END MILL WITH SPHERICAL RADIUS 2. CHECK FOR RUNNING TRUE 3. SET SPINDLE SPEED AND FEED AS PER IX-B-3(TS)
4. MACHINE FIRST SIDE  Fig. 1	1. ADJUST TABLE FEED UNTIL BOTTOM OF END MILL IS EXACTLY 11/16" ABOVE TABLE. REFER TO FIG. 1 2. LOCK TABLE 3. MOVE CROSS FEED AND LONGITUDINAL FEED UNTIL CUTTER TOUCHES FOREMOST POINT OF WORKPIECE NOTE: OUTSIDE OF WORKPIECE 4. SET LONGITUDINAL FEED DIAL ON "O" 5. CLEAR WORKPIECE FROM CUTTER NOTE: MOVE CROSS FEED IN OR OUT

STEPS | KEY POINTS

Fig. 2



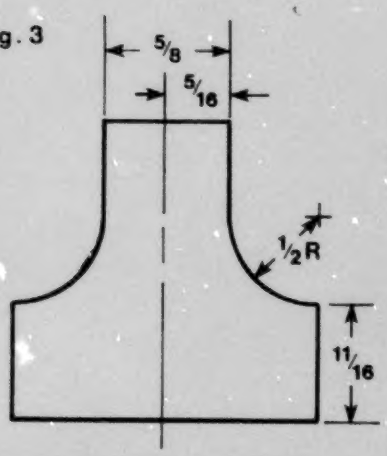
NOTE: USE CONVENTIONAL MILLING METHOD

6. SET LONGITUDINAL FEED FOR .050" CUT
NOTE: CUTTING WILL BE PERFORMED WITH CROSS FEED
7. FEED CUTTER IN FOR FIRST CUT
NOTE: IF USING POWER FEED, SET FEED RATE THE SAME AS IN PREVIOUS TASK IX-B-3(TS): IF HAND FED, KEEP CONSTANT UNIFORM FEED ALLOWING CUTTER TO FUNCTION PROPERLY WITHOUT BURNING CUTTER OR SCRAPING
8. AFTER FIRST CUT MOVE LONGITUDINAL FEED IN .050" AND MAKE SECOND CUT
NOTE: REPEAT OPERATION UNTIL RADIUS IS CUT TO PROPER SIZE
NOTE: HOLD 5/16" FROM REFERENCE CENTER LINE WITH DEPTH 11/16" FROM BOTTOM OF HOLDER. REFER TO FIG. 2
9. INSPECT WORKPIECE FOR SPECIFIED DIMENSIONS

5. MACHINE SECOND SIDE

1. POSITION WORKPIECE SO CUTTER WILL BE ON OPPOSITE SIDE FROM FIRST SIDE
2. MACHINE SIDE USING SAME PROCEDURE AS IN MACHINING FIRST SIDE
CAUTION: REVERSE FEED DIRECTION
3. MACHINE TO FINISH SIZE
NOTE: HOLD 5/8" WIDTH AND 11/16" DEPTH AS SPECIFIED AND SHOWN IN FIG. 3
4. HOLD FOR NEXT TASK, "MILL TOOL HOLDER TO FINISHED HEIGHT"

Fig. 3



SKETCHES: DRAWING #2C, PART #3, TOOL HOLDER, RADIUS CUTTER

REFERENCE: INSTRUCTOR

TASK SHEET IX-B-3b(TS)

TASK: SET UP AND MILL TOOL HOLDER TO FINISH HEIGHT

JOB: RADIUS CUTTER

TRADE: MACHINIST

TOOLS AND MATERIALS: VERTICAL MILLING MACHINE, 1" ENDMILL, ENDMILL HOLDER, DEPTH MICROMETER, 6" RULE

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP WORKPIECE	NOTE: SETUP WILL REMAIN THE SAME AS IN PREVIOUS TASKS IX-B-3(TS) AND IX-B-3a(TS)
2. SET MACHINE	1. INSPECT AND INSTALL 1" END MILL NOTE: THE END MILL WILL NOT CONTAIN ANY RADIUS ON THE CUTTING LIPS 2. CHECK FOR RUNNING TRUE 3. SET SPINDLE SPEED AND FEED AS PER IX-B-3(TS) NOTE: SPINDLE SPEED MAY BE INCREASED WITH THIS TYPE CUTTER. SEE INSTRUCTOR
3. MACHINE TOP OF TOOL HOLDER	1. POSITION WORKPIECE DIRECTLY UNDER END MILL 2. RAISE TABLE UNTIL CUTTER TOUCHES WORKPIECE SLIGHTLY NOTE: SHIM MATERIAL MAY BE USED 3. SET VERTICAL FEED DIAL ON "O" 4. CLEAR WORKPIECE FROM CUTTER 5. MEASURE TOTAL HEIGHT ON WORKPIECE 6. REMOVE NECESSARY MATERIAL TO HOLD SPECIFIED SIZE. TOTAL HEIGHT 1 11/16" 7. INSPECT WORKPIECE NOTE: HOLD ALL SPECIFIED DIMENSIONS 8. BURR EDGES 9. ROUTE TO BENCH FOR LAYOUT

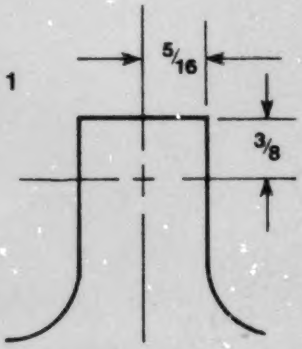
SKETCHES: DRAWING #2C, PART #3, TOOL HOLDER, RADIUS CUTTER

REFERENCES: SEE INSTRUCTOR

TASK SHEET IV-B-2a(TS)

TASK:	LAY OUT CENTER FOR TAPPED HOLE AND SQUARE HOLE
JOB:	RADIUS CUTTER
TRADE:	MACHINIST
TOOLS AND MATERIALS:	BENCH PLATE, SURFACE GAGE, LAYOUT INK, SCRIBE, 6" RULE, PRICK PUNCH, CENTER PUNCH, BALL PEEN HAMMER, DRILL VISE, AND COMBINATION SQUARE

TASK BREAKDOWN:

STEPS	KEY POINTS
1. LAY OUT CENTER FOR TAPPED HOLE	1. POSITION WORKPIECE ON LAYOUT TABLE NOTE: TURNED PART FOR HOB WILL BE FACE DOWN 2. SCRIBE LINE 5/16" FROM FRONT EDGE OF PREVIOUS MILLED ½" RADII. REFER TO IX-B-3b(TS) NOTE: THIS CENTER LINE SHOULD BE SCRIBED FROM STEP IN IX-B-3(TS). CHECK THE ACCURACY OF LINE AS TO SPECIFICATIONS 3. ALONG PREVIOUS SCRIBED CENTER LINE LAY OUT A DISTANCE 5/16" FROM TOP LEFT EDGE OF WORKPIECE NOTE: THE INTERSECTION OF THE TWO CENTER LINES IS THE CENTER FOR THE ¼"-20-NC TAPPED HOLE 4. LOCATE CENTER WITH CENTER PUNCH
2. LAY OUT AND LOCATE CENTER FOR ¼" SQUARE HOLE Fig. 1  	1. INK LEFT SIDE OF WORKPIECE 2. POSITION WORKPIECE ON BENCH PLATE NOTE: POSITION UPRIGHT WITH TOP FACE UP 3. SCRIBE HORIZONTAL LINE 3/8" DOWN FROM TOP FACE ACROSS THE LEFT EDGE OF WORKPIECE. REFER TO FIG. 1 NOTE: THIS WILL BE THE UPPER PART OF THE BODY NOTE: THIS MAY BE DONE WITH A RULE OR SURFACE GAGE 4. SCRIBE LINE PERPENDICULAR TO PREVIOUS CENTER LINE 5/16" FROM FRONT EDGE OF 1/2" RADII MILLED SURFACE.

STEPS	KEY POINTS
	REFER TO FIG. 1
	5. LOCATE CENTER WITH CENTER PUNCH
	6. INSPECT LAYOUT FOR ACCURACY
	7. ROUTE TO DRILL PRESS

SKETCHES: DRAWING #2C, PART #3, TOOL HOLDER, RADIUS CUTTER

VI-B-2(J)

JOB SHEET
ON
DRILL PRESS

JOB: RADIUS CUTTER

MATERIAL: PART #3, TOOL HOLDER, AS MACHINED IN PREVIOUS TASK

TOOLS AND EQUIPMENT: DRILL PRESS, 1/4" DRILL, #7 DRILL, 9/16" COUNTER BORE WITH 3/8" PILOT, COMBINATION SQUARE, AND DRILL VISE

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 95-119; REF. #4, PP. 177-120, REF. #5, PP. 115-138. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE AND UPON COMPLETION OF OPERATION

PROCEDURES AND/OR TASKS:

VI-A-1(TS)	CHECK DRILL PRESS FOR PROPER OPERATING CONDITION
*VI-B-2(TS)	DRILL 1/4" HOLE THROUGH
*VI-B-2a(TS)	DRILL #7 HOLE NOTE: DRILL TO 1/4" HOLE PREVIOUSLY DRILLED
*VI-B-2b(TS)	SET UP AND COUNTER BORE 9/16" HOLE

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS

1. CHECK FOR CORRECT AND ACCURATE SETUP
2. PROPER SELECTION AND INSPECTION OF TOOL
3. MAINTAIN OBSERVATION OF ALL SAFETY RULES
4. MAINTAIN CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS

TASK SHEET

VI-B-2(TS)

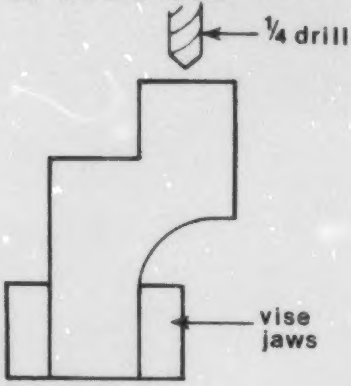
TASK: SET UP DRILL 1/4" HOLE THROUGH

JOB: RADIUS CUTTER

TRADE: MACHINIST

TOOLS AND MATERIALS: DRILL PRESS, VISE, CHUCK AND KEY, 1/4" DRILL, COMBINATION SQUARE, AND PART #3, TOOL HOLDER AS MACHINED IN PREVIOUS TASK

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP WORKPIECE  	1. CLEAN DRILL TABLE 2. WIPE INSIDE OF DRILL VISE CLEAN 3. MOUNT WORKPIECE IN VISE NOTE: CLAMP WORKPIECE IN VISE ON THE TOP AND BOTTOM FACE OF HOB 4. CHECK WORKPIECE FOR SQUARE WITH DRILL TABLE 5. CLAMP WORKPIECE FIRMLY IN VISE 6. SECURE VISE TO TABLE NOTE: DEPENDING ON DRILL VISE SIZE IT MAY NOT BE NECESSARY TO CLAMP VISE TO TABLE
2. SET UP MACHINE	1. SELECT AND INSPECT DRILL 2. INSTALL DRILL BIT 3. CHECK FOR RUNNING TRUE 4. SET SPINDLE SPEED AT ABOUT 1500 R.P.M.
3. DRILL HOLE	1. LOCATE DRILL BIT OVER CENTER PUNCHED HOLE 2. TURN MACHINE ON 3. FEED DRILL DOWN CAREFULLY TO ALIGN PROPERLY WITH CENTER 4. DRILL HOLE THROUGH NOTE: MAINTAIN PROPER FEED AND LUBRICATION 5. INSPECT AND BURR HOLE

SKETCHES: DRAWING #2C, PART #3, TOOL HOLDER, RADIUS CUTTER

TASK SHEET

TASK:	DRILL #7 HOLE
JOB:	RADIUS CUTTER
TRADE:	MACHINIST
TOOLS AND MATERIALS:	DRILL PRESS, VISE, CHUCK AND KEY, #7 DRILL, AND PART #3, TOOL HOLDER, AS MACHINED IN PREVIOUS TASKS

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP WORKPIECE	1. MOUNT WORKPIECE IN VISE NOTE: CHECK TO INSURE WORKPIECE IS LEVEL SQUARE WITH DRILL SPINDLE 2. CLAMP WORKPIECE FIRMLY
2. SET UP MACHINE	1. SELECT AND INSPECT DRILL 2. INSTALL #7 DRILL 3. CHECK FOR RUNNING TRUE 4. SET SPINDLE SPEED
3. DRILL HOLE	1. LOCATE AND ALIGN DRILL WITH PUNCH 2. TURN MACHINE ON 3. DRILL HOLE CAREFULLY TO DEPTH OF 1/4" PREVIOUSLY DRILLED HOLE NOTE: LUBRICATE DRILL AND MAINTAIN PROPER FEED 4. INSPECT AND BURR

SKETCHES: DRAWING #2C, PART #3, TOOL HOLDER, RADIUS CUTTER

TASK SHEET

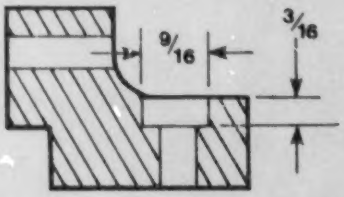
TASK: SET UP AND COUNTERBORE 9/16" HOLE

JOB: RADIUS CUTTER

TRADE: MACHINIST

TOOLS AND MATERIALS: DRILL PRESS, VISE CHUCK AND KEY, 9/16" COUNTER BORE WITH 3/8" PILOT, AND PART #3, TOOL HOLDER, AS MACHINED IN PREVIOUS TASK

TASK BREAKDOWN:

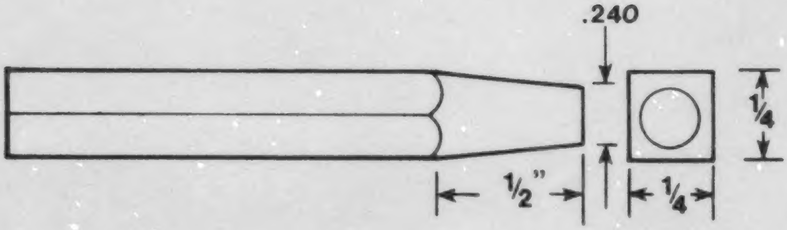
STEPS	KEY POINTS
1. SET UP MACHINE	1. SELECT AND INSPECT 9/16" COUNTER-BORE AND 3/8" PILOT
	2. INSTALL COUNTER BORE AND PILOT
	3. CHECK FOR RUNNING TRUE
	4. SET STOP FOR 3/16" DEPTH
	5. SET SPINDLE SPEED AT 60R. P. M.
2. SET UP WORKPIECE	1. WORKPIECE IS CLAMPED IN VISE AS IN PREVIOUS TASK VI-B-2a(TS)
	2. ALIGN WORKPIECE WITH PILOT NOTE: LUBRICATE PILOT BEFORE INSERTING INTO REAMED HOLE
	3. CLAMP MATERIAL AND VISE FIRMLY
	4. RECHECK ALIGNMENT
3. COUNTER BORE HOLE	1. TURN MACHINE ON
	2. FEED COUNTERBORE DOWN SLOWLY NOTE: AT THE START OF CUT, THE COUNTERBORE WILL BE ON 3/4" RADII. FEED SLOWLY AND CAUTIOUSLY
	3. COUNTER BORE TO DEPTH
	4. INSPECT AND BURR HOLE
	5. REMOVE WORKPIECE
	6. SECURE MACHINE
	7. ROUTE TO BENCH FOR TAPPING AND BROACHING

SKETCHES: DRAWING #2C, PART #3, TOOL HOLDER, RADIUS CUTTER

X-B-1(J)

JOB SHEET
ON
GRINDER

JOB:	RADIUS CUTTER



SPECIAL BROACH

MATERIALS:	MADE FROM 1/4" x 1/4" H.S.S. LATHE TOOL
TOOLS AND EQUIPMENT:	PEDESTAL GRINDER, 0-1" MICROMETER, 6" RULE, AND HONE
GENERAL INSTRUCTIONS:	BEFORE BEGINNING THIS JOB, STUDY THE ABOVE DRAWING, READ REF. #3, PP. 121-125; REF. # 4, PP. 143-147

PROCEDURES AND/OR TASKS:	X-B-1(TS)	CHECK GRINDER FOR PROPER OPERATING CONDITION
	X-B-1a(TS)	DRESS AND TRUE GRINDING WHEEL
	*X-B-1b(TS)	GRIND SPECIAL BROACH ROUTE TO ARBOR PRESS

CHECK POINTS:	STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASK

1. CHECK OPERATING CONDITION OF GRINDER
2. GRINDING WHEEL PROPERLY DRESSED
3. OBSERVANCE OF ALL SAFETY REGULATIONS

TASK SHEET

X-B-1b(TS)

TASK: GRIND SPECIAL BROACH

JOB: RADIUS CUTTER

TRADE: MACHINIST

TOOLS AND MATERIALS: 1/4" x 1/4" SQUARE H. S. S. LATHE TOOL, BENCH OR PEDESTAL GRINDER, 0-1" MICROMETER, 6" RULE, AND HONE

TASK BREAKDOWN:

STEPS	KEY POINTS
1. DRESS GRINDING WHEEL	1. FACE WHEEL 2. TRUE WHEEL NOTE: USE DIAMOND POINT WHEEL DRESSER CAUTION: PRACTICE ALL SAFETY PRECAUTIONS AND WEAR SAFETY EYE PROTECTION
2. GRIND BROACH	1. SELECT 1/4" x 1/4" H. S. STEEL TOOL 2. GRIND ONE END SQUARE NOTE: THIS END WILL BE PLACED AGAINST ARBOR PRESS RAM 3. PLACE TOOL IN HORIZONTAL POSITION ON GRINDER TOOL REST 4. TURN GRINDER ON CAUTION: DO NOT LET TOOL COME IN CONTACT WITH WHEEL 5. GRIND POINT OF TOOL TO A ROUNDED TAPER NOTE: HOLD TOOL AT SLIGHT ANGLE SO AS TO PRODUCE A TAPER 1/2" LONG. REFER TO DRAWING 6. GRIND TOOL BY SLOWLY TURNING UNTIL END OF BIT IS .240" NOTE: CHECK WITH 0-1" MICROMETER 7. INSPECT FOR SMOOTH CONICAL SURFACE 8. HONE BROACH TO INSURE CLEAN SHARP CUTTING EDGE 9. INSPECT ROUTE TO ARBOR PRESS

SKETCHES: SEE ATTACHED DRAWING ON JOB SHEET

TASK SHEET

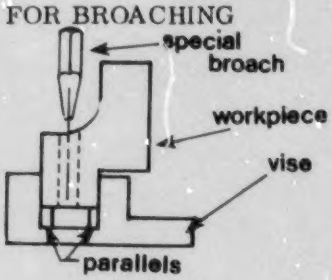
TASK: SET UP AND BROACH 1/4" SQUARE HOLE

JOB: RADIUS CUTTER

TRADE: MACHINIST

TOOLS AND MATERIALS: ARBOR PRESS, SPECIAL BROACH AND PART #3, TOOL HOLDER AS MACHINED IN PREVIOUS TASKS

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP WORKPIECE FOR BROACHING  Fig. 1	1. WIPE TABLE OF ARBOR PRESS CLEAN 2. PLACE WORKPIECE IN VISE NOTE: POSITION AS SHOWN IN FIG. 1 3. PLACE TWO PARALLELS TO SUPPORT WORKPIECE NOTE: BE SURE THEY CLEAR THE HOLE TO BE BROACHED 4. CLAMP WORKPIECE TIGHTLY IN VISE NOTE: CHECK FOR SQUARE WITH ARBOR PRESS TABLE
2. BROACH SQUARE HOLE	1. LUBRICATE BOTH WORKPIECE AND BROACH 2. PLACE BROACH INTO WORKPIECE NOTE: TAPERED POINT WILL PERMIT EASY START 3. LOWER ARBOR PRESS UNTIL CONTACT WITH BROACHING TOOL IS MADE NOTE: CHECK TO SEE THAT BROACH IS PLACED IN WORKPIECE IN A VERTICAL POSITION 4. PRESS BROACH THROUGH WORKPIECE NOTE: APPLY FIRM CONSTANT PRESSURE TO ARBOR PRESS 5. REMOVE WORKPIECE FROM VISE 6. REMOVE BROACH 7. BURR EDGES WITH FILE

SKETCHES: DRAWING #2C, PART #3, TOOL HOLDER, RADIUS CUTTER

TASK SHEET VII-B-4a(TS)

TASK: FINISH TURN TOOL HOLDER BASE TO 1 11/16" DIAMETER

JOB: RADIUS GUIDE

TRADE: MACHINIST

TOOLS AND MATERIALS: ENGINE LATHE, FACE PLATE, 3/8" MANDREL, DRIVE DOG, DEAD CENTER, LINE CENTER, TURNING TOOL, 1-2" MICROMETER AND MILL FILE

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP WORKPIECE	1. SELECT AND INSPECT 3/8" MANDREL
	2. LUBRICATE MANDREL
	3. PRESS MANDREL INTO 3/8" REAMED HOLE NOTE: MANDREL TO PRESS INTO COUNTER BORE HOLE FIRST NOTE: INSPECT FOR SQUARENESS
	4. MOUNT DRIVE DOG ON MANDREL
	5. MOUNT FACE PLATE ON LATHE
	6. INSTALL DEAD CENTER IN TAILSTOCK
	7. MOUNT WORKPIECE BETWEEN CENTERS NOTE: LUBRICATE DEAD CENTER POINT
	8. CHECK FOR RUNNING TRUE
2. SET UP MACHINE	1. INSTALL TURNING TOOL NOTE: TOOL IS GROUND TO PRODUCE SQUARE SHOULDER
	2. SET SPINDLE SPEED AND FEED
3. TURN DIAMETER	1. TURN DIAMETER TO 1.6875"
	2. SQUARE SHOULDER FOR MINIMUM CLEAN-UP CAUTION: BE CAREFUL OF WORKPIECE HITTING TOOL HOLDER OR COMPOUND REST NOTE: HOLD 11/16" FROM END AS PER DRAWING

SKETCHES: DRAWING #2C, PART #3, TOOL HOLDER, RADIUS CUTTER

TASK SHEET VII-B-4b(TS)

TASK: TURN 1/4" x 1 7/16" DIAMETER

JOB: RADIUS CUTTER

TRADE: MACHINIST

TOOLS AND MATERIALS: ENGINE LATHE, FACE PLATE, CUT-OFF TOOL, 6" RULE, MILL FILE, DRIVE DOG, DEAD CENTER, LIVE CENTER, 1-2" MICROMETER, AND PART #3, AS MACHINED IN PREVIOUS TASKS

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP TOOL	NOTE: IT IS NOT PRACTICAL TO USE A CUT-OFF TOOL FOR TURNING; HOWEVER, SOMETIMES IT IS NECESSARY 1. SET UP TOOL AS BEFORE, PERPENDICULAR TO WORKPIECE AND CENTERED 2. POSITION PARTING TOOL UNTIL RIGHT SIDE IS 7/16" FROM END OF WORKPIECE 3. LOCK CARRIAGE
2. SET UP MACHINE	1. SET MACHINE IN BACK GEAR NOTE: SPEED SHOULD BE FAST ENOUGH TO PREVENT TEARING MATERIAL AND NOT SO FAST AS TO CAUSE CHATTER 2. TIGHTEN CROSS SLIDE GIB ADJUSTMENT TO PREVENT ANY PLAY NOTE: SEE INSTRUCTOR
3. TURN DIAMETER	NOTE: WHEN TURNING WITH CUT-OFF TOOL, PLUNGE CUT ONLY 1. TURN MACHINE ON 2. TURN DIAMETER TO HOLD 1.4375" NOTE: HOLD CLOSE TOLERANCE AND SQUARE SHOULDER NOTE: MARK ON CROSS SLIDE COLLAR THE DEPTH READING 3. BACK TOOL OUT 4. LOOSEN CARRIAGE LOCK 5. TURN CARRIAGE LONGITUDINAL HAND WHEEL TO MOVE CUT-OFF TOOL 1/8" TOWARD HEADSTOCK NOTE: HOLD 11/16" FROM END AS PER DRAWING. REFER TO FIG. 1

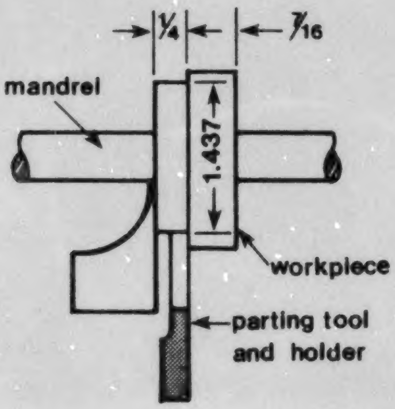


Fig. 1

STEPS	KEY POINTS
	6. LOCK CARRIAGE
	7. PLUNGE TURN AGAIN TO PREVIOUS DEPTH NOTE: BLEND IN WITH 1.4375" DIAMETER NOTE: THE REFERENCE MARK ON COLLAR SHOULD GIVE DEPTH
	8. BURR EDGES

SKETCHES: DRAWING NO. 2C, PART #3, TOOL HOLDER, RADIUS CUTTER

TASK SHEET VII-B-4c(TS)

TASK: SET UP AND TURN 2.2375" DIAMETER

JOB: RADIUS CUTTER

TRADE: MACHINIST

TOOLS AND MATERIALS: ENGINE LATHE, FACE PLATE, 3/8" MANDREL, DRIVE DOG, DEAD CENTER, LIVE CENTER, 5/16" TOOL WITH SPHERICAL RADII, 2-3" MICROMETER, MILL FILE, TWO 5/16" PRECISION GROUND PINS, AND PART #3, TOOL HOLDER AS PREVIOUSLY MACHINED

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP TOOL	1. SET UP TOOL ON CENTER AND PERPENDICULAR TO WORKPIECE 2. SET CENTER OF TOOL 7/32" FROM END OF WORKPIECE NOTE: THIS WILL BE THE CENTER OF HOB 3. LOCK CARRIAGE
2. MACHINE DIAMETER	1. SET MACHINE IN BACK GEAR OR SLOW SPEED 2. FEED TOOL INTO WORKPIECE SAME AS FOR FORM TURNING REFER TO FIG. 1 3. TURN TO 2.2375" DIAMETER NOTE: USE TWO PRECISION GROUND PINS FOR MIKING DIAMETER. PLACE PINS ON EACH SIDE OF THE RADIUS AND MIKE OVER THEM. THE OVERALL DIAMETER SHOULD BE 2.2375" AS PER DRAWING 4. BURR EDGES

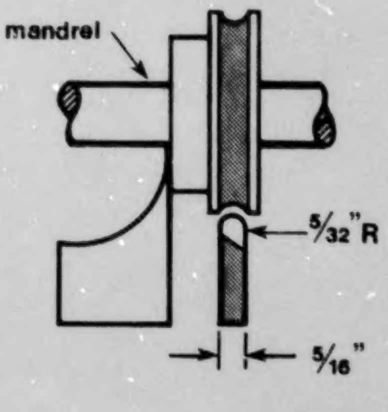


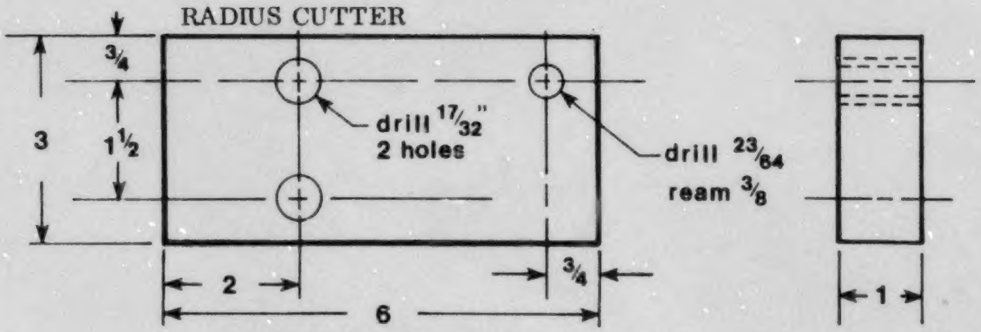
Fig. 1

SKETCHES: DRAWING NO. 2C, PART #3, TOOL HOLDER, RADIUS CUTTER

VI-B-3(J)

JOB SHEET
ON
DRILL PRESS

JOB: RADIUS CUTTER



SPECIAL TOOL POST FIXTURE

*NOTE: SPECIAL FIXTURE CAN BE MADE FROM SCRAP PLATE. THE ACTUAL THICKNESS DEPENDS UPON THE SIZE ENGINE LATHE TO BE MOUNTED UPON. ACTUAL SIZE WILL BE DETERMIND BY THE INSTRUCTOR

MATERIALS: 1" x 3" x 6" PLATE AS SPECIFIED ABOVE OR TO MEET SPECIFIC SIZE FOR LATHE TO BE USED UPON

TOOLS AND EQUIPMENT: DRILL PRESS, CHUCK AND KEY, 23/64" DRILL, 17/32" DRILL, 3/8" REAMER, DRILL VISE, COMBINATION SQUARE, SCRIBE, LAYOUT INK, LAYOUT TABLE, PRICK PUNCH, CENTER PUNCH, BALL PEEN HAMMER, AND 6" RULE

GENERAL INSTRUCTIONS: CHECK WITH INSTRUCTOR FOR SPECIFIC INFORMATION PERTAINING TO CHANGE IN MATERIAL SIZES BEFORE BEGINNING THIS JOB. CHECK WITH INSTRUCTOR UPON COMPLETION OF JOB BEFORE PROCEEDING TO NEXT JOB

PROCEDURES AND/OR TASKS:

PROCEDURES AND/OR TASKS:	IV-B-1(TS)	OBTAIN MATERIAL FROM SUPPLY
	*VI-B-3(TS)	CONSTRUCT SPECIAL TOOL POST FIXTURE
		ROUTE TO ENGINE LATHE TO MAKE SETUP

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS

1. CHECK LAYOUT FOR ACCURACY
2. CHECK DRILL PRESS FOR PROPER OPERATING CONDITIONS
3. OBSERVE AND MAINTAIN ALL SAFETY PROCEDURES
4. MAINTAIN CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS

TASK SHEET

VI-B-3(TS)

TASK: CONSTRUCT SPECIAL TOOL POST FIXTURE

JOB: RADIUS CUTTER: SPECIAL TOOL POST FIXTURE

TRADE: MACHINIST

TOOLS AND MATERIALS: LAYOUT INK, SCRIBE, COMBINATION SQUARE, 6" RULE, LAYOUT TABLE, PRICK PUNCH, CENTER PUNCH, BALL PEEN HAMMER, DRILL PRESS, CHUCK AND KEY, DRILL VISE, 23/64" DRILL, 17/32" DRILL, 3/8" REAMER, AND 1" x 3" x 6" PLATE

TASK BREAKDOWN:

STEPS	KEY POINTS
1. OBTAIN MATERIAL	1. MATERIAL TO BE FROM SCRAP IF AVAILABLE 2. THICKNESS WILL BE DETERMINED BY LATHE SIZE 3. BURR EDGES PRIOR TO MAKING LAYOUT
2. LAY OUT HOLES	1. PAINT WORKPIECE FACE WITH LAYOUT DYE 2. WITH ONE EDGE AS REFERENCE, SCRIBE CENTER LINE FULL LENGTH OF WORKPIECE 3/4" FROM EDGE NOTE: THIS WILL LOCATE ONE 17/32" HOLE AND THE 3/8" REAMED HOLE FROM THE EDGE 3. WITH SAME EDGE AS REFERENCE, SCRIBE LINE PARALLEL TO PREVIOUS LINE 2 1/4" FROM REFERENCE EDGE NOTE: LINE SHOULD MAINTAIN 1 1/2" DISTANCE FROM PREVIOUS LINE 4. SCRIBE LINE PARALLEL TO LEFT EDGE OF WORKPIECE 2" FROM END NOTE: WHERE LINE INTERSECTS THE TWO PREVIOUS LINES WILL BE THE CENTERS FOR THE TWO 17/32" DRILLED HOLES 5. SCRIBE LINE PARALLEL TO LINE IN #4 AND PARALLEL TO RIGHT END 3/4" FROM RIGHT END NOTE: THE INTERSECTION OF THE TWO LINES WILL LOCATE CENTER FOR 3/4" REAMED HOLE

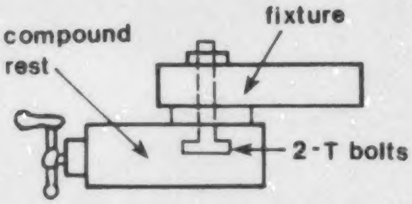
STEPS	KEY POINTS
	6. CHECK ACCURACY OF LAYOUT
	7. LOCATE CENTERS WITH PRICK PUNCH
	8. CENTER PUNCH HOLES
3. DRILL 17/32" HOLES	1. SET UP DRILL PRESS SPINDLE SPEED
	2. INSTALL 17/32" DRILL
	3. SET UP WORKPIECE IN DRILL VISE
	4. DRILL HOLES THROUGH
4. DRILL AND REAM 3/8" HOLE	1. SET UP 23/64" DRILL
	2. LOCATE AND ALIGN WORKPIECE WITH DRILL
	3. DRILL HOLE THROUGH
	4. REPLACE DRILL WITH REAMER
	5. SET SPINDLE SPEED NOTE: 1/2 OF SPEED FOR DRILLING
	6. REAM HOLE TO SIZE NOTE: WORKPIECE NOT HAVING BEEN MOVED ASSURING ALIGNMENT NOTE: BE SURE VISE IS SECURE TO TABLE
	7. REMOVED WORKPIECE
	8. BURR ALL EDGES
	ROUTE TO LATHE TO MAKE SPECIAL SETUP

SKETCHES: ATTACHED DRAWING ON JOB SHEET

TASK SHEET VII-B-4d(TS)

TASK:	SET UP SPECIAL FIXTURE AND MOUNT WORKPIECE
JOB:	RADIUS CUTTER
TRADE:	MACHINIST
TOOLS AND MATERIALS:	ENGINE LATHE, SPECIAL FIXTURE, PART #3, AS MACHINED IN PREVIOUS TASKS, 3/8"-16 NC BOTTOMING TAP, DRIVE DOG, LIVE CENTER, TWO T-BOLTS WITH NUTS, NECESSARY WRENCHES, AND PART #3, TOOL HOLDER AS MACHINED

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP FIXTURE  compound rest fixture 2-T bolts Fig. 1	1. REMOVE TOOL POST FROM COMPOUND REST NOTE: STORE IN PROPER PLACE 2. WIPE COMPOUND REST CLEAN 3. SET UP SPECIAL FIXTURE ON COMPOUND REST NOTE: BOLT FIXTURE LOOSELY TO COMPOUND REST REFER TO FIG. 1
2. SET UP WORKPIECE	1. PLACE WORKPIECE ON SPECIAL FIXTURE REFER TO FIG. 2

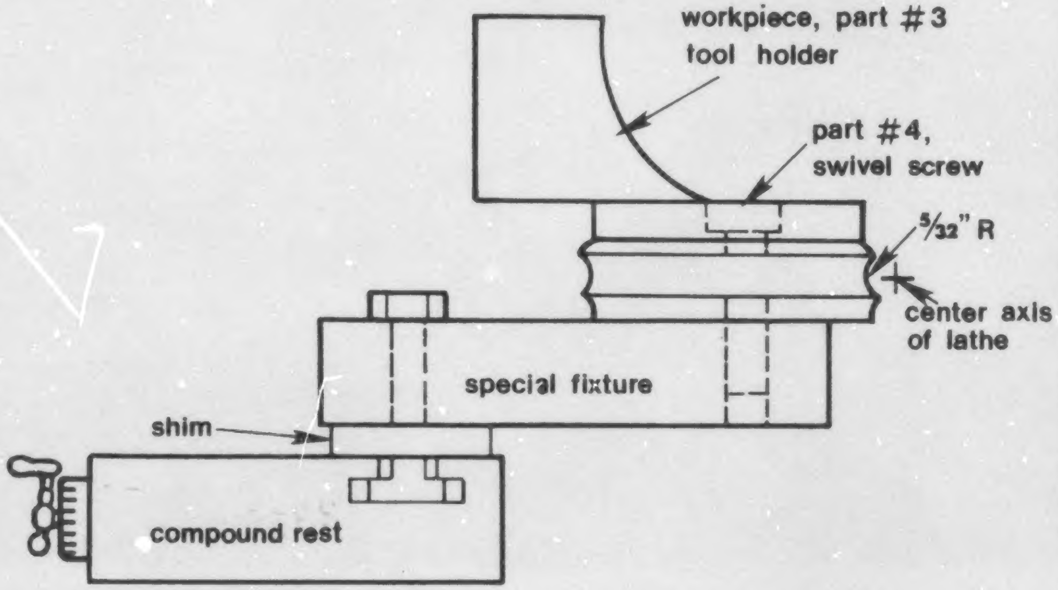

workpiece, part #3
tool holder
part #4,
swivel screw
5/32" R
center axis
of lathe
special fixture
shim
compound rest

Fig. 2

STEPS	KEY POINTS
	2. ATTACH WORKPIECE TO FIXTURE BY INSERTING PART #4, SWIVEL SCREW THROUGH FIXTURE AND INTO 3/8" REAMED AND COUNTER BORED HOLE ON TOOL HOLDER NOTE: DO NOT PLACE NUT ON PART #4, AS IT WILL TIGHTEN WHEN WORKPIECE REVOLVES AND WILL RESULT IN DAMAGING WORKPIECE
3. SHIM SPECIAL FIXTURE	1. POSITION WORKPIECE ON CENTER WITH THE LATHE CENTER AXIS NOTE: THE CENTER OF 5/32" RADII MUST BE ON CENTER WITH THE LATHE. SHIM WORKPIECE AS NECESSARY. REFER TO FIG. 2 2. TIGHTEN "T" BOLTS FIRMLY 3. RECHECK CENTERING OF WORKPIECE

SKETCHES: DRAWING #2C, PART #3, TOOL HOLDER, RADIUS CUTTER

TASK SHEET

VII-B-4e(TS)

TASK:	TURN HOB
JOB:	RADIUS CUTTER
TRADE:	MACHINIST
TOOLS AND MATERIALS:	ENGINE LATHE, SPECIAL FIXTURE, PART #4, SWIVEL SCREW, 3/8"-16 NC BOTTOMING TAP, DRIVE DOG, LIVE CENTER, TWO "T" BOLTS, AND PART #3, TOOL HOLDER AS MACHINED IN PREVIOUS TASKS

TASK BREAKDOWN:

STEPS	KEY POINTS
1. INSTALL TAP	1. MOUNT DRIVE DOG ON END OF TAP SHANK
	2. PLACE LIVE CENTER HEAD STOCK SPINDLE
	3. PLACE DEAD CENTER IN TAILSTOCK SPINDLE
	4. MOUNT TAP BETWEEN CENTERS NOTE: LUBRICATE CENTERS
2. POSITION WORKPIECE	1. MOVE CARRIAGE LONGITUDINALLY UNTIL WORKPIECE IS CENTERED ON TAP CAUTION: CHECK TO SEE THAT THE WORKPIECE WILL CLEAR THE DRIVE DOG WHEN IT REVOLVES
	2. LOCK CARRIAGE
3. TURN HOB	1. SET SPINDLE IN BACK GEAR
	2. TURN MACHINE ON
	3. TURN CROSS FEED HANDLE CLOCKWISE FEEDING WORKPIECE INTO TAP. REFER TO FIG. 1 CAUTION: DO NOT APPLY TOO MUCH PRESSURE ON THE TAP AND BREAK THE TAP NOTE: LUBRICATE TAP FREELY CAUTION: BE SURE WORKPIECE CLEARS DRIVE DOG NOTE: AS THE MACHINE TURNS THE TAP, THE TAP WILL CUT INTO THE WORKPIECE AND CAUSE IT TO REVOLVE
	4. CONTINUE TO FEED IN AFTER EACH

STEPS KEY POINTS

COMPLETE REVOLUTION OF THE WORKPIECE

NOTE: CONTINUE TO FEED IN UNTIL SHARP THREADS ARE OBTAINED

CAUTION: DO NOT MOVE LONGITUDINAL FEED OR MOVE COMPOUND REST AT AN ANGLE

NOTE: CONTINUE TO FLOOD TAP WITH COOLANT TO CLEAR METAL SHAVINGS FROM TEETH

5. INSPECT TEETH FOR PROPER DEPTH
6. REMOVE WORKPIECE AND BURR
7. SECURE MACHINE AND TOOLS
8. ROUTE TO BENCH FOR ASSEMBLY

SKETCHES:

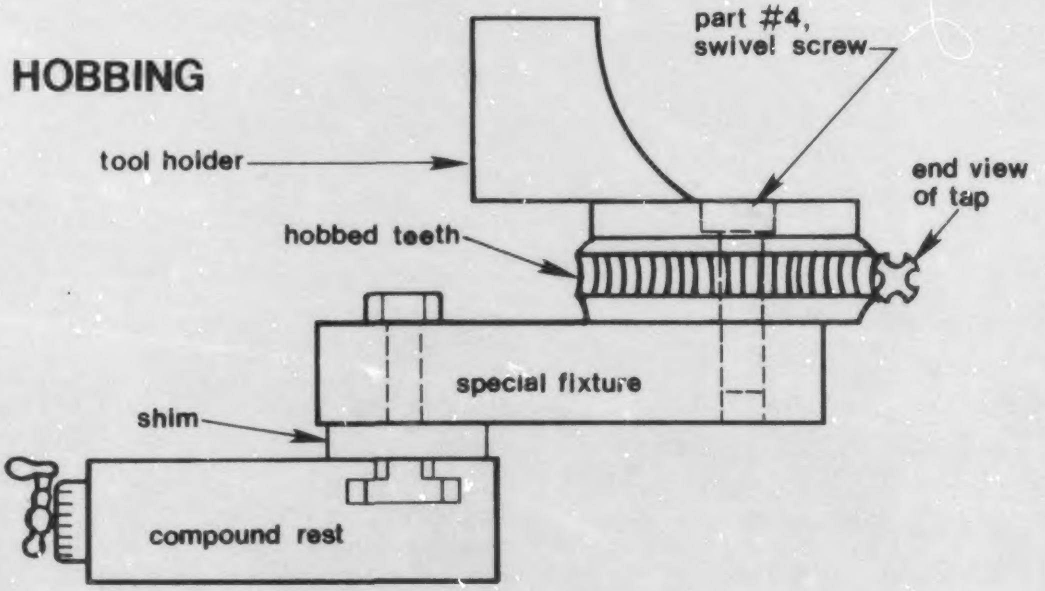

HOBBING
part #4, swivel screw
tool holder
end view of tap
hobbed teeth
special fixture
shim
compound rest

Fig. 1

NAME ____________________

PROGRESS CHART
MACHINE SHOP – PART III

TASKS	SAW			BENCH							DRILL					SHAPER			MILLING MACHINE									ENGINE LATHE																							SURF. GR				TOOLGR		
JOB SURFACE GAGE	VERTICAL BAND SAWING (ST.)	VERTICAL BAND SAWING (RADII)	HORIZONTAL BAND SAWING (ST.)	PREPARE SURFACE FOR LAYOUT	LAYOUT	BEND AND FORM	BROACH	TAP	HEAT TREAT	ASSEMBLE	DRILL TO LAYOUT	COUNTERBORE	COUNTERSINK	REAM	TAP	HORIZONTAL SHAPING	ANGLE SHAPING	FORM SHAPING	END MILLING	FACE MILLING	DRILLING	REAMING	INDEXING	SLITTING	SLOTTING	ANGLE MILLING	FORM MILLING	MOUNT WORK IN CHUCK	MOUNT WORK BETWEEN CENTERS	FACE	CENTER DRILL	TURN	TURN SHOULDER	TURN TAPER W/COMPOUND REST	TURN TAPER W TAPER ATTACH.	DRILL	REAM	BORE	COUNTERBORE	COUNTERSINK	GROOVE AND NECK	TURN RADII	FORM	KNURL	CUT THREADS	HOB GEAR	CUT OFF	TAP	FILE	TAPER BORE	DRESS AND TRUE WHEEL	GRIND PLAIN SURFACE	GRIND ANGULAR SURFACE	GRIND SLOT	DRESS AND TRUE WHEEL	GRIND TAPER	GRIND STRAIGHT SURFACE
PART #2 MARKER																																																									
PART #3 SCRIBER																																																									
PART #4 POST																																																									
PART #5 CLAMP																																																									
PART #6 WASHER "A"																																																									
PART #8 SHOULDER SCREW																																																									
PART #9 WASHER "B"																																																									
PART #10 PRESSURE CUP																																																									
PART #11 PIVOT SCREW "B"																																																									
PART #12 PIVOT SCREW "A"																																																									
PART #13 PRESSURE SLEEVE																																																									
PART #15 WASHER "C"																																																									
PART #16 ANGLE WASHER																																																									
PART #17 EASE																																																									
PART #18 PRESSURE NUT "B"																																																									
PART #19 ADJUSTING SCREW																																																									
PART #20 PIN																																																									
PART #22 PRESSURE NUT "A"																																																									
PART #23 SHOULDER SCREW																																																									
PART #24 ROCKER																																																									

MACHINE SHOP SURFACE GAGE

BENCH

BAND SAW

DRILL PRESS

HORIZONTAL MILLING MACHINE

VERTICAL MILLING MACHINE

HEAT TREAT

SHAPER

SURFACE GRINDER

AIM: THE STUDENT WILL BE ABLE TO SELECT MATERIAL, READ AND INTERPRET BLUEPRINT, SELECT CORRECT TOOLING, MAKE OWN SETUP, AND CONSTRUCT A SURFACE GAGE ACCORDING TO SPECIFICATIONS.

CHECKING STANDARDS

1. SELECTION OF TOOLS, EQUIPMENT, AND SUPPLIES
2. SETUP AND PREPARATION OF MACHINE
3. LAYOUT ACCORDING TO PRINT SPECIFICATIONS
4. HOLD ALL DIMENSIONS TO PRINT SPECIFICATIONS
5. HOLD ALL SURFACES TO PRECISION FINISH
6. MAINTAIN TOOLS AND EQUIPMENT IN GOOD WORKING ORDER
7. MAINTAIN SAFE WORKING ATTITUDE
8. MAINTAIN AN ATTITUDE OF APPRECIATION FOR WORK, MATERIALS, TOOLS, EQUIPMENT, AND MACHINES

REFERENCES

REF. #1, WALKER, JOHN R., MODERN METALWORKING

REF. #2, LUDWIG, OSWALD A. AND MCCARTHY, WILLARD J., METALWORK TECHNOLOGY AND PRACTICE

REF. #3, WALKER, JOHN R., MACHINING FUNDAMENTALS

REF. #4, MCCARTHY, WILLARD J. AND SMITH, ROBERT E., MACHINE TOOL TECHNOLOGY

REF. #5, KRAR, S. F., OSWALD, J. W., AND ST. AMAND, J. E., TECHNOLOGY OF MACHINE TOOLS

REF. #6, ANDERSON, JAMES AND TATRO, EARL E., SHOP THEORY

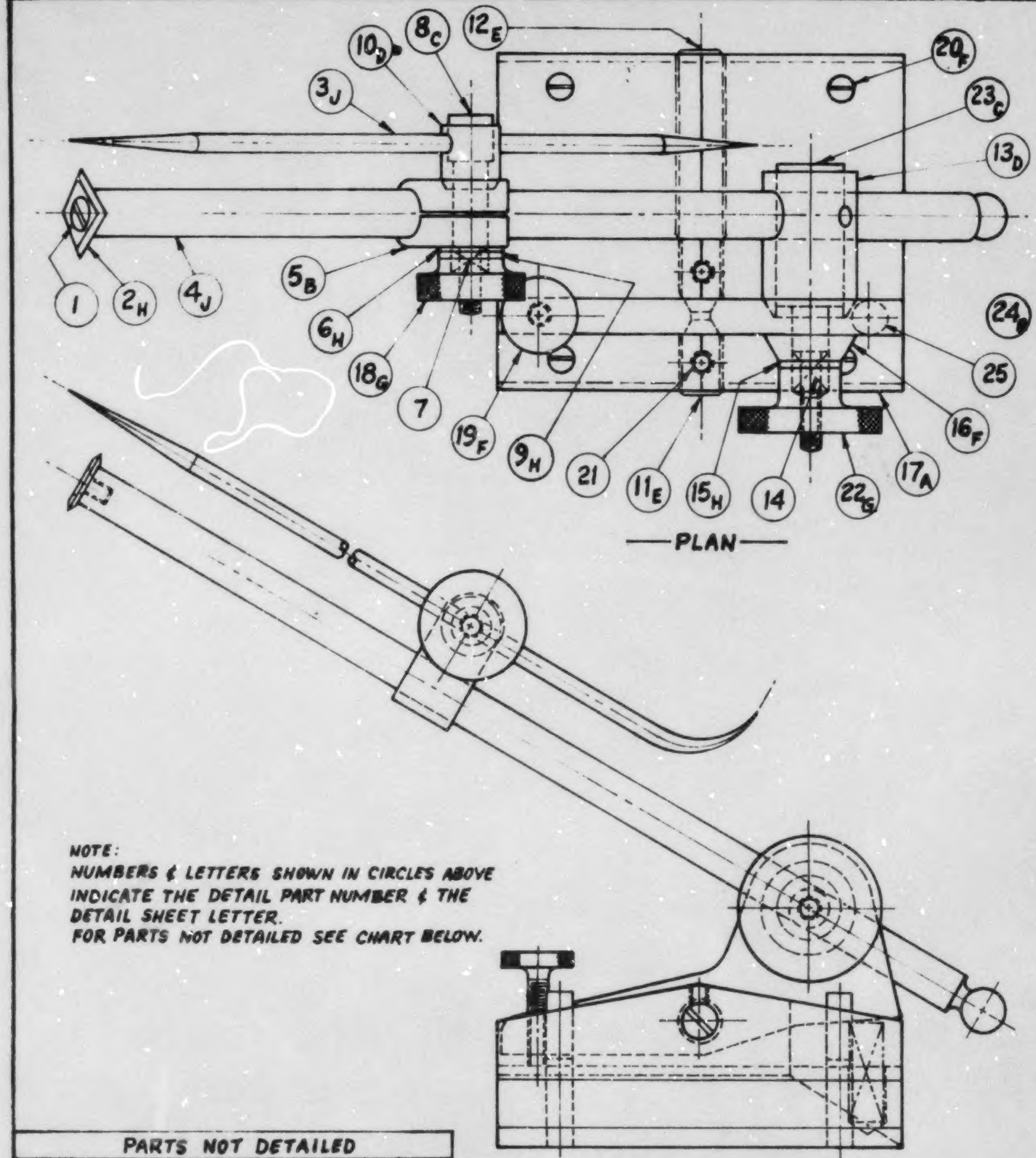
REF. #7, PORTER, HAROLD W., LASCOE, ORVILLE D., AND NELSON, CLYDE A., MACHINE SHOP OPERATIONS AND SETUPS

NOTE: IN THIS JOB THE STUDENT WILL GET THE MATERIAL FROM SUPPLY FOR EACH PART PRIOR TO THE CONSTRUCTION OF THAT PART. THE STUDENT IS CHARGED WITH KEEPING TRACK OF EACH COMPLETED PART AND THE PROPER STORAGE OF THAT PART TO PREVENT DAMAGE TO THE PART.

THE JOB AND TASK SHEETS ARE WRITTEN IN THE SEQUENTIAL ORDER OF CONSTRUCTING THE PART. UPON COMPLETION, THE PART WILL BE HELD FOR ASSEMBLY.

AT THIS STAGE OF TRAINING NO REFERENCE WILL BE MADE TO THOSE TASKS THAT HAVE BEEN PERFORMED REPEATEDLY IN PART I AND PART II. A TASK SHEET THAT IS WRITTEN WILL CONCERN ITSELF ONLY WITH THE TOTAL OPERATION OF A JOB RATHER THAN WITH SPECIFIC TASKS, AS WAS THE CASE IN PARTS I AND II. IN ADDITION, THOSE TASKS REQUIRING SPECIAL OPERATIONS OR SETUPS WILL BE WRITTEN. THE STUDENT IS EXPECTED TO FUNCTION PROPERLY WITH THIS METHOD.

NOTE: ONLY THOSE TASKS WITH AN ASTERISK BY THEM WILL BE WRITTEN OUT COMPLETELY.

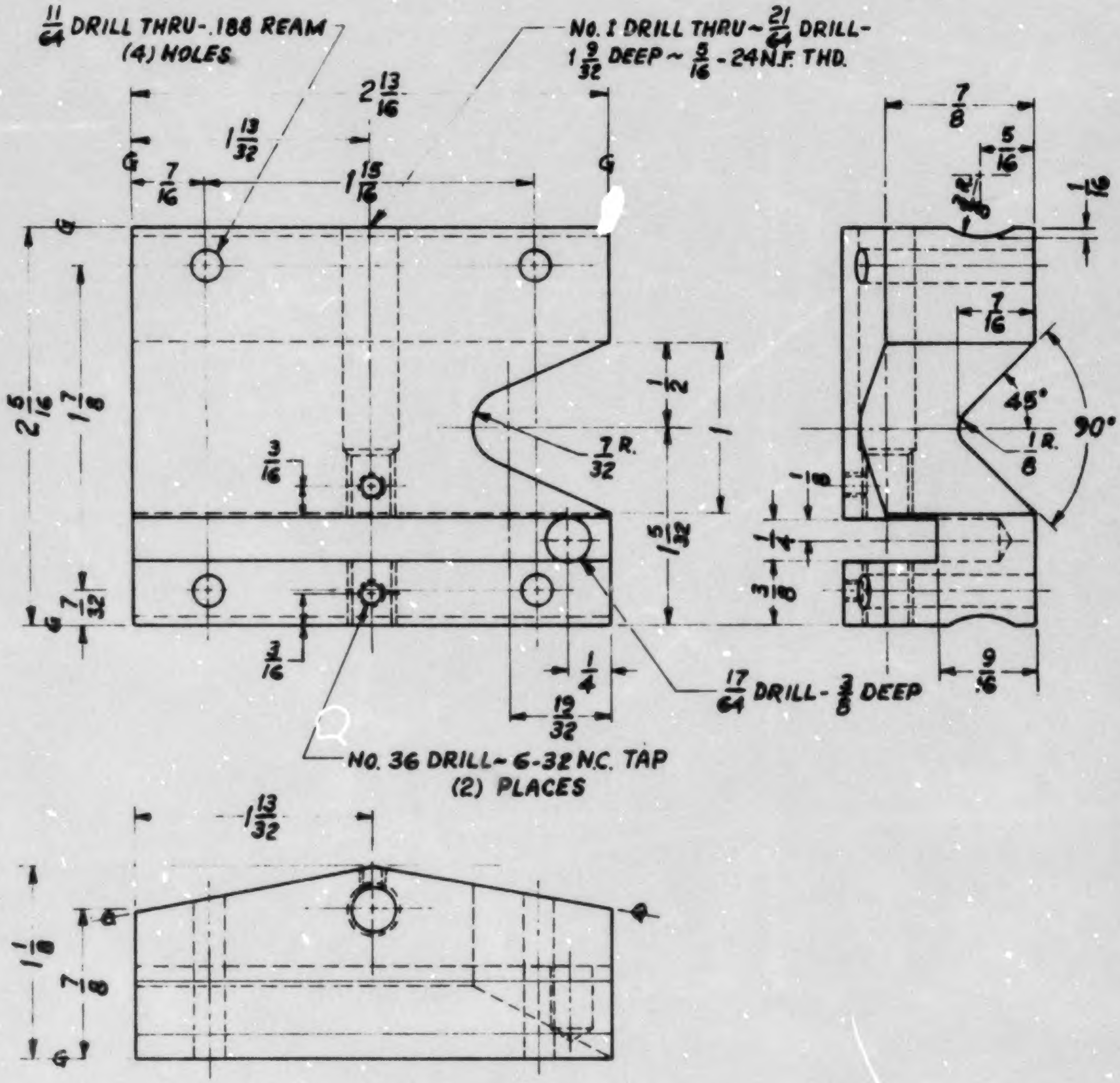

10_D
8_C
12_E
20_F
3_J
23_C
13_D
1
2_H
4_J
5_B
6_H
24_B
18_G
7
19_F
9_H
21
11_E
15_H
14
22_G
17_A
16_F
25
—PLAN—
—ELEVATION—

NOTE:
NUMBERS & LETTERS SHOWN IN CIRCLES ABOVE INDICATE THE DETAIL PART NUMBER & THE DETAIL SHEET LETTER.
FOR PARTS NOT DETAILED SEE CHART BELOW.

PARTS NOT DETAILED

NO.	QUAN	DESCRIPTION	MATL
1	1	6-32 N.C. × 3/16 LG. F.H. MACH. SCW.	STD.
7	1	SPRING-1/4 O.D. × 1/4 LG. 13 GA.	M.W.
14	1	SPRING-1/4 O.D. × 3/8 LG. 13 GA.	M.W.
21	2	6-32 N.C. × 3/16 LG. SOC. SET SCW.	STD.
25	1	SPRING-1/4 O.D. × 1/2 LG. 13 GA.	M.W.

DRAWING NO. 3	SURFACE GAGE-ASSEMBLY	TOLERANCES UNLESS OTHERWISE NOTED
SEE DETAILS 3-A THRU J	MATERIAL: SEE DETAILS FINISH: SEE DETAILS SCALE: FULL SIZE	FRACTIONS - ± 1/64" DECIMALS - ± .005" ANGLES - ± 1/4 °



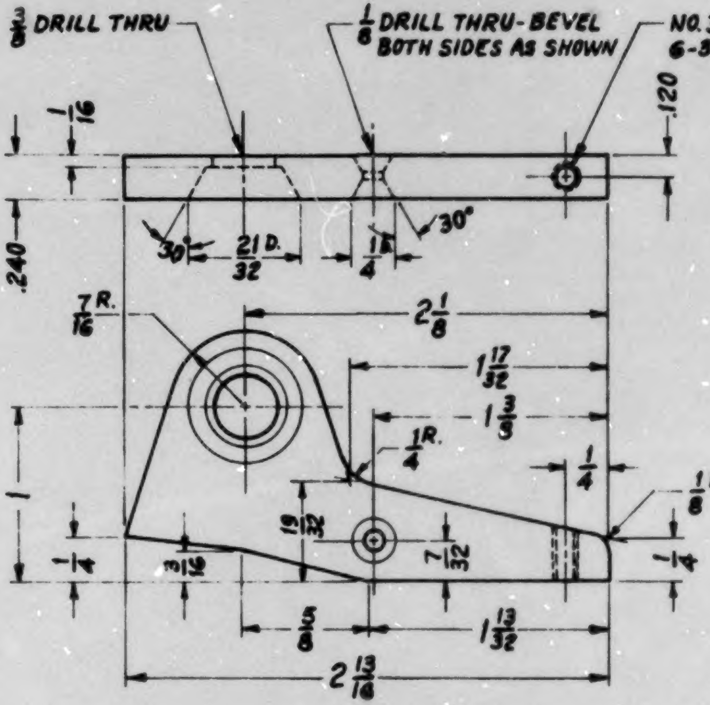
11/64 DRILL THRU-.188 REAM (4) HOLES
NO. 1 DRILL THRU ~ 21/64 DRILL-1 9/32 DEEP ~ 5/16-24N.F. THD.
2 13/16
1 13/32
1 15/16
7/16
G
2 5/16
1 7/8
3/16
7/32
1/2
1
7/32 R.
1 5/32
1/4
19/32
17/64 DRILL-3/8 DEEP
NO. 36 DRILL ~ 6-32 N.C. TAP (2) PLACES
7/8
5/16
7/16
1/16
45°
90°
1/8 R.
9/16
3/8
1 1/8

17

BASE

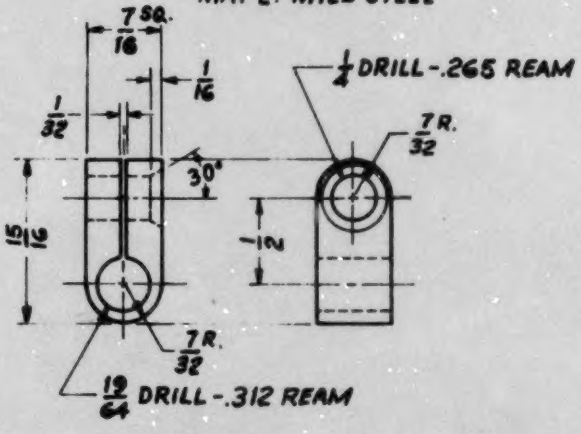
BREAK ALL SHARP CORNERS & EDGES
ALLOW .010 OVER; ALL SURFACES TO BE GROUND

DRAWING NO. 3-A	SURFACE GAGE DETAILS	TOLERANCE CHART
BENCH JOB NO. MILLING JOB NO. SHAPER JOB NO. DRILL PRESS JOB NO. SURFACE GRINDER JOB NO.	MATERIAL: MILD STEEL FINISH: GRIND SCALE: FULL SIZE	FRACTIONS ± 1/64 DECIMALS ±.005 ANGLES ± 1/2°


3/8 DRILL THRU
1/8 DRILL THRU - BEVEL BOTH SIDES AS SHOWN
NO. 36 DRILL THRU ~ 6-32 N.C. TAP THRU
1/16
.120
.240
30°
21/32 D.
1/4
30°
7/16 R.
2 1/8
1 17/32
1 3/8
1/4 R.
1/4
1/8 R.
19/32
7/32
1
1/4
3/16
1/4
5/8
1 13/32
2 13/16

(24)

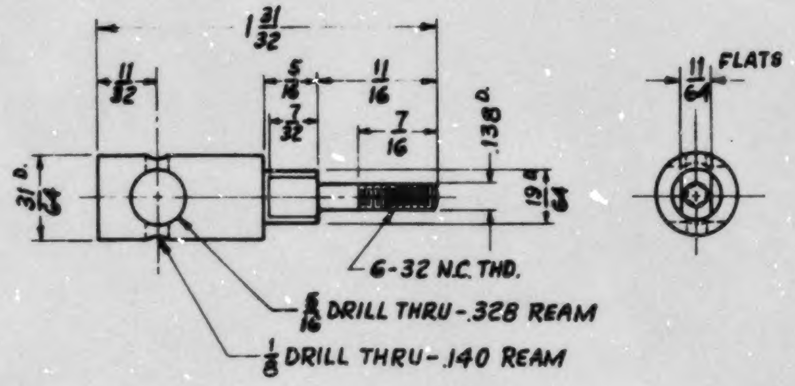
ROCKER ~ (1) REQ'D
MAT'L: MILD STEEL


7/16 SQ.
1/16
1/32
1/4 DRILL - .265 REAM
7/32 R.
30°
15/16
1/2
7/32 R.
19/64 DRILL - .312 REAM

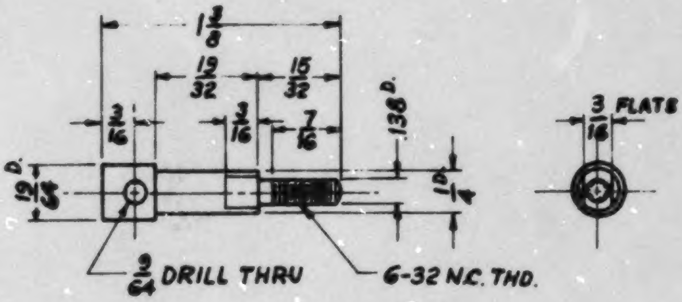
(5)

CLAMP ~ (1) REQ'D
MAT'L: C.R. STEEL

DRAWING NO. 3-B	SURFACE GAGE DETAILS	TOLERANCE CHART
BENCH JOB NO. DRILL PRESS JOB NO. SURFACE GRINDER JOB NO.	MATERIAL: (AS SHOWN) FINISH: POLISH SCALE:	FRACTIONS ± 1/64 DECIMALS ±.005 ANGLES ± 1/2°

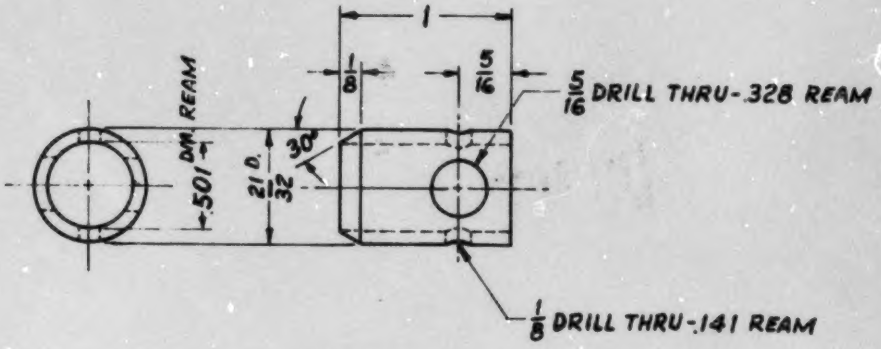

1 31/32
11/32
5/16
11/16
7/32
7/16
.138 D.
31/64 D.
19/64
11/64 FLATS
6-32 N.C. THD.
5/16 DRILL THRU-.328 REAM
1/8 DRILL THRU-.140 REAM

(23) SHOULDER SCREW

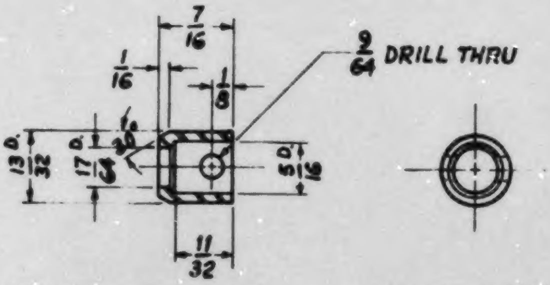

1 3/8
19/32
15/32
3/16
3/16
7/16
.138 D.
19/64 D.
1/4 D.
3/16 FLATS
9/64 DRILL THRU
6-32 N.C. THD.

(8) SHOULDER SCREW

DRAWING NO. 3-C	SURFACE GAGE DETAILS	TOLERANCE CHART
LATHE JOB NO.	MATERIAL: C.R. STEEL	FRACTIONS ± 1/64
MILLING JOB NO.	FINISH: POLISH	DECIMALS ±.005
DRILL PRESS JOB NO.	SCALE: FULL SIZE	ANGLES ± 1/2°

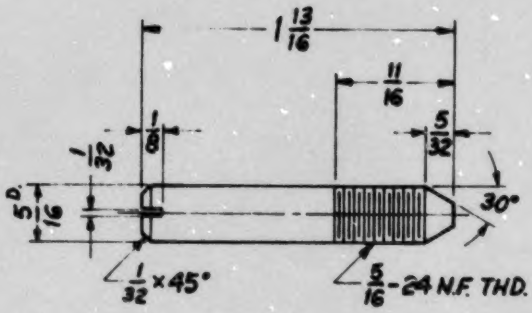

1
1/8
5/16
5/16 DRILL THRU-.328 REAM
.501 DIA REAM
21/32 D.
30°
1/8 DRILL THRU-.141 REAM

(13) PRESSURE SLEEVE

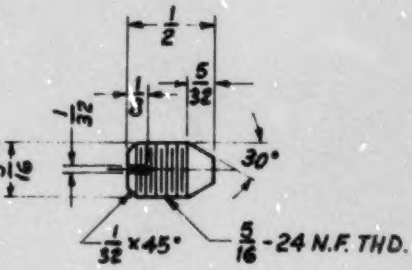

7/16
1/16
1/8
9/64 DRILL THRU
13/32 D.
17/64 D.
1/16
30°
5/16 D.
11/32

(10) PRESSURE CUP

DRAWING NO. 3-D	SURFACE GAGE DETAILS	TOLERANCE CHART
TURRET LATHE JOB NO. DRILL PRESS JOB NO.	MATERIAL: C.R. STEEL FINISH : SCALE : FULL SIZE	FRACTIONS ± 1/64 DECIMALS ±.005 ANGLES ± 1/4°

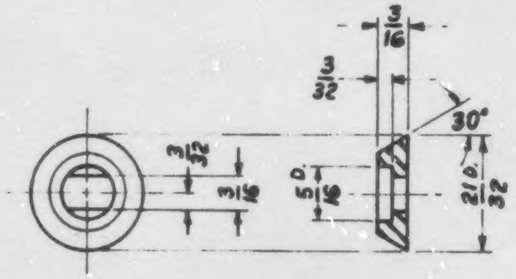

1 13/16
11/16
1/8
5/32
1/32
5 D./16
30°
1/32 ×45°
5/16-24 N.F. THD.

⑫ PIVOT SCREW-A

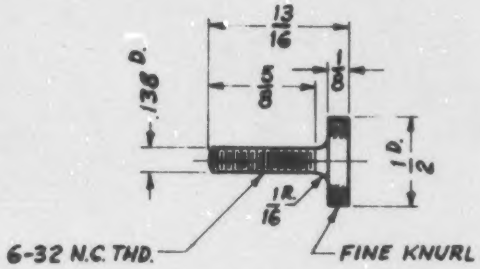

1/2
1/8
5/32
1/32
5 D./16
30°
1/32 ×45°
5/16-24 N.F. THD.

⑪ PIVOT SCREW-B

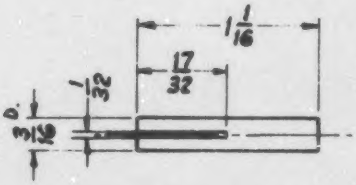
DRAWING NO. 3-E	SURFACE GAGE DETAILS	TOLERANCE CHART
LATHE JOB NO. MILLING JOB NO.	MATERIAL : C.R. STEEL FINISH : SCALE : FULL SIZE	FRACTIONS ±1/64 DECIMALS ±.005 ANGLES ±1/4°


3/16
3/32
30°
3/32
3/16
5/16 D.
21/32 D.

(16) ANGULAR WASHER

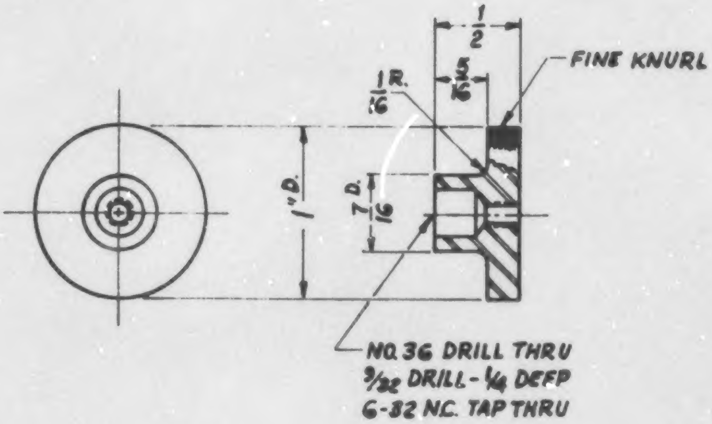

13/16
5/8
1/8
.138 D.
1/2 D.
1/16 R.
6-32 N.C. THD.
FINE KNURL

(19) ADJUSTING SCREW

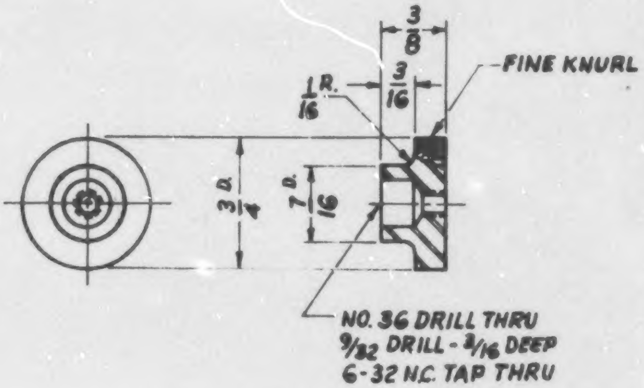

1 1/16
17/32
1/32
3/16 D.

(20) PIN

DRAWING NO. 3-F	SURFACE GAGE DETAILS	TOLERANCE CHART
TURRET LATHE JOB NO. MILLING JOB NO.	MATERIAL: C.R. STEEL FINISH: SCALE: FULL SIZE	FRACTIONS ±1/64 DECIMALS ±.005 ANGLES ±1/4°

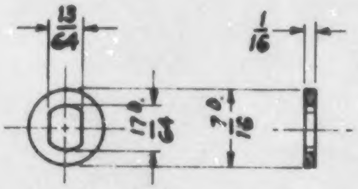

1/2
5/16
1/16 R.
FINE KNURL
1" D.
7/16 D.
NO. 36 DRILL THRU
9/32 DRILL - 1/4 DEEP
6-32 N.C. TAP THRU

(22) PRESSURE NUT - A

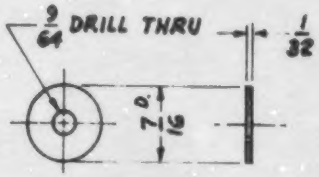

3/8
3/16
1/16 R.
FINE KNURL
3/4 D.
7/16 D.
NO. 36 DRILL THRU
9/32 DRILL - 3/16 DEEP
6-32 N.C. TAP THRU

(18) PRESSURE NUT - B

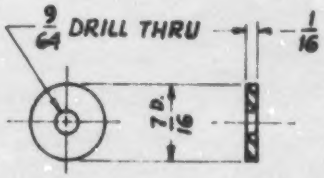
DRAWING NO. 3-G	SURFACE GAGE DETAILS	TOLERANCES UNLESS OTHERWISE NOTED
TURRET LATHE JOB NO.	MATERIAL: C.R. STEEL FINISH: SCALE: FULL SIZE	FRACTIONS - ± 1/64" DECIMAL - ± .005" ANGLES - ± 1/4 °


13/64
1/16
17/64 D.
7/16 D.

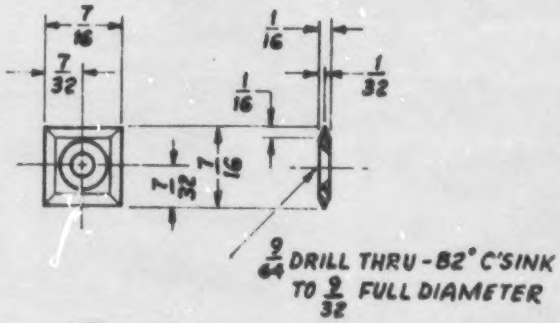
⑥ WASHER-A
MAT'L: MILD STEEL


9/64 DRILL THRU
1/32
7/16 D.

⑨ WASHER-B
MAT'L: MILD STEEL

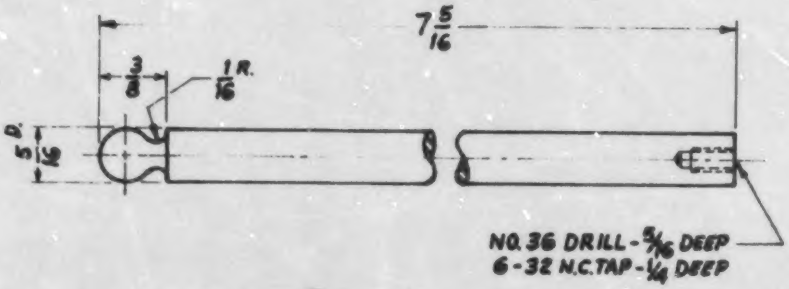

9/64 DRILL THRU
1/16
7/16 D.

⑮ WASHER-C
MAT'L: MILD STEEL

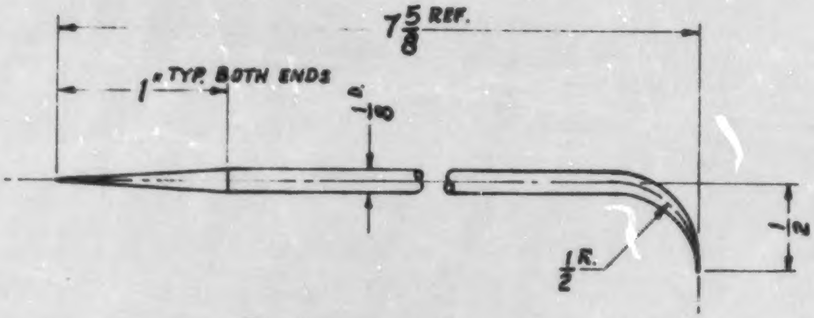

7/16
7/32
1/16
1/32
1/16
7/16
7/32
9/64 DRILL THRU - 82° C'SINK
TO 9/32 FULL DIAMETER

② MARKER
MAT'L: TOOL STEEL

DRAWING NO. 3-H	SURFACE GAGE DETAILS	TOLERANCES UNLESS OTHERWISE NOTED
TURRET LATHE JOB NO. BENCH JOB NO.	MATERIAL: AS NOTED FINISH: TOOL SCALE: FULL SIZE	FRACTIONS - ± 1/64" DECIMAL - ± .005" ANGLES - ± 1/4°


7 5/16
3/8
1/16 R.
5/16 D.
NO. 36 DRILL - 5/16 DEEP
6-32 N.C. TAP - 1/4 DEEP

④ POST


7 5/8 REF.
1" TYP. BOTH ENDS
.190 D.
1/2 R.
1/2

③ SCRIBER
HARDEN & POLISH

DRAWING NO 3-J	SURFACE GAGE DETAILS	TOLERANCES UNLESS OTHERWISE NOTED
TURRET LATHE JOB NO. BENCH JOB NO.	MATERIAL: DRILL ROD FINISH: SCALE: FULL SIZE	FRACTIONS - ± 1/64" DECIMAL - ± .005" ANGLES - ± 1/4°

VIII-B-1(J)

JOB SHEET
ON
SHAPER

JOB: SURFACE GAGE

MATERIALS: 1 3/8" x 2 1/2" x 3" 1020 MILD STEEL FOR PART #17 BASE

TOOLS AND EQUIPMENT: SHAPER, UNIVERSAL VISE, ROUGHING TOOL, FINISHING TOOL, DIAL INDICATOR, 6" RULE, PARALLELS, CUTTING OIL

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 209-225; REF. #4, PP. 291-313; REF. #5, PP. 197-216. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE.

NOTE: THOSE TASKS WITH AN ASTERISK BY THEM ARE WRITTEN OUT

PROCEDURE AND/OR TASK:

VIII-A-1(TS)	CHECK SHAPER FOR PROPER OPERATING CONDITION
VIII-B-1a(TS)	SET UP TOOLING AND UNIVERSAL VISE
*VIII-B-1a(TS)	MACHINE BASE SQUARE AND TO SIZE NOTE: HOLD DIMENSIONS .010" OVERSIZE FOR SURFACE GRINDING AS NOTED ON PRINT NO. 3-A
VIII-B-1b(TS)	CLEAN MACHINE ROUTE TO SURFACE GRINDER

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICACATED POINTS BEFORE PROCEEDING WITH TASKS.

1. CHECK MACHINE FOR PROPER OPERATING CONDITIONS.
2. CHECK MACHINE FOR PROPER SETUP OF TOOLING AND VISE.
3. ALL DIMENSIONS HELD TO SPECIFICATIONS.
4. OBSERVANCE OF SAFE WORKING HABITS.
5. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR MACHINE TOOLS, EQUIPMENT, SUPPLIES, AND STANDARDS.

TASK SHEET VIII-B-1a(TS)

TASK: MACHINE BASE SQUARE AND TO SIZE

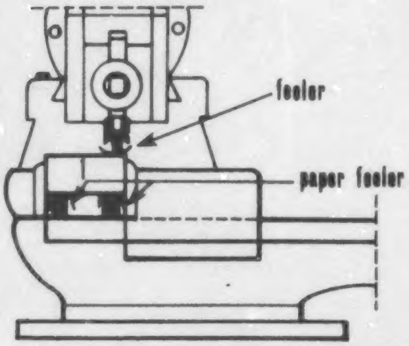
JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND EQUIPMENT: 1 PIECE - 1 3/8" x 2 1/2" x 3" 1020 MILD STEEL, SHAPER, SWIVEL BASE UNIVERSAL VISE, FINISH AND/OR ROUGHING TOOL, DIAL INDICATOR, 6" RULE, PARALLELS, SOFT ROUND STOCK, LEAD HAMMER, COMBINATION SQUARE, COOLANT OR CUTTING OIL

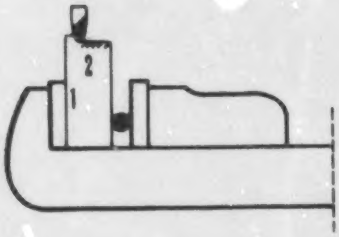
TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP UNIVERSAL VISE	1. CHECK SHAPER TABLE FOR CHIPS, DIRT, AND BURRS 2. CHECK BASE OF VISE FOR CLEANLINESS AND BURRS 3. SET VISE WITH JAWS PARALLEL TO RAM STROKES 4. TIGHTEN T-BOLTS TO SECURE VISE ON TABLE 5. TEST VISE JAWS FOR ALIGNMENT WITH RAM STROKE NOTE: USE DIAL INDICATOR 6. TEST VISE WORK SEAT FOR PARALLELISM TO RAM STROKE NOTE: USE DIAL INDICATOR
2. MACHINE FIRST SURFACE (FACE)	1. SET WORKPIECE IN VISE NOTE: LARGEST SIDE FACE UP 2. PLACE WORKPIECE ON PARALLELS. REFER TO FIG. 1 NOTE: PLACE PAPER FEELER BETWEEN PARALLELS AND WORKPIECE 3. TIGHTEN VISE FIRMLY AND TAP WORKPIECE LIGHTLY WITH LEAD HAMMER NOTE: CHECK PAPER FEELERS TO INSURE TIGHTNESS 4. SET SHAPER STROKE LENGTH, POSITION, AND SPEED NOTE: TOOL SHOULD EXTEND BEYOND WORKPIECE 1/2" AT THE FAR POINT OF STROKE AND 1" AT THE BEGINNING OF STROKE



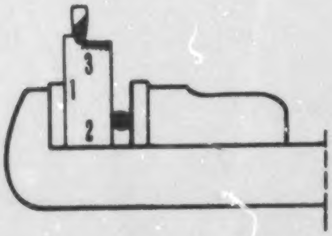
5. LOWER TOOL SLIDE UNTIL TOOL BIT COMES IN CONTACT WITH WORKPIECE
   NOTE: USE FEELER TO CHECK FOR HIGH POINT ON WORKPIECE. REFER TO FIG. 1
6. CLEAR TOOL FROM WORKPIECE
   NOTE: SET MICROMETER COLLAR AT "O"
7. SET DEPTH CUT
   NOTE: REMOVE ONLY ENOUGH TO CLEAN UP FACE OF WORKPIECE
8. MACHINE FIRST FACE
   NOTE: BURR EDGES UPON REMOVAL
9. WIPE VISE CLEAN

3. MACHINE SECOND SURFACE (1ST EDGE)



1. PLACE FIRST MACHINED FACE AGAINST SOLID JAWS
2. PLACE ROUND ROD BETWEEN MOVABLE JAW AND SECOND FACE. REFER TO FIG. 2
   NOTE: ROD IS PLACED IN THE CENTER OF THE WORKPIECE
3. ADJUST TOOL BIT TO WORK SURFACE AS PER STEP #2
4. MACHINE SECOND SURFACE AS PER STEP #2
   NOTE: BURR EDGES ON REMOVAL
5. WIPE VISE CLEAN

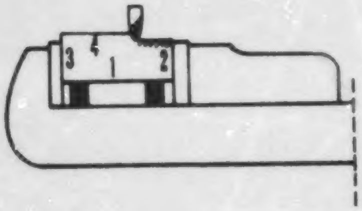
4. MACHINE THIRD SURFACE (2ND EDGE)



1. PLACE FIRST FACE AGAINST SOLID JAW
2. PLACE SECOND SURFACE AT BOTTOM OF VISE
3. PLACE ROUND ROD BETWEEN MOVABLE JAW AND SECOND FACE. REFER TO FIG. 3
4. MACHINE THIRD SURFACE TO SIZE
   NOTE: ALLOW .010" OVERSIZE FOR SURFACE GRINDING. HOLD 2.323"
5. REMOVE WORKPIECE AND BURR EDGES
6. WIPE VISE CLEAN

5. MACHINE FOURTH SURFACE (2ND FACE)

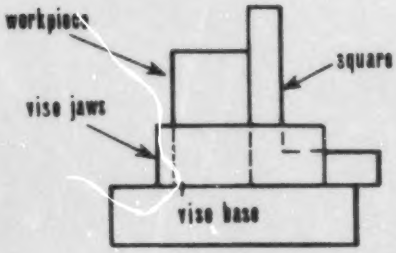
1. SET UP WORKPIECE. REFER TO FIG. 4
   NOTE: WITH THREE FINISHED SURFACES, THE ROUND ROD IS NOT REQUIRED



CAUTION: CLEAN ALL PARTS OF VISE JAWS AND PARALLELS AND BURR EDGES OF WORKPIECE BEFORE MAKING SETUP OF WORKPIECE

2. MACHINE TO SIZE
NOTE: ALLOW .010" FOR SURFACE GRINDING. HOLD 1.135"

6. MACHINE FIRST END (FIFTH SURFACE)



1. PLACE WORKPIECE ON ONE END IN THE VISE
NOTE: THE TWO FINISHED FACES WILL BE PLACED AGAINST THE SOLID AND MOVABLE JAW
2. CHECK EDGE OF WORKPIECE FOR SQUARE WITH VISE BASE
NOTE: CHECK WITH SQUARE AS IN FIG. 5
NOTE: DIAL INDICATOR MAY ALSO BE USED
3. MACHINE END FOR CLEAN UP ONLY
4. REMOVE WORKPIECE AND BURR EDGES

7. MACHINE SECOND END (SIXTH SURFACE)

1. PLACE NONMACHINED END UPRIGHT
NOTE: WORKPIECE WILL BE PLACED END FOR END FROM STEP #6. REF. TO FIG. 5
2. SQUARE EDGE WITH VISE BASE AS IN STEP #6
NOTE: DIAL INDICATOR MAY BE USED
3. MACHINE TO SIZE
NOTE: ALLOW .010" FOR SURFACE GRINDING THE TWO ENDS. HOLD 2.823" LENGTH
4. REMOVE AND BURR EDGES
5. INSPECT FOR SQUARE AND ACCURACY
NOTE: ALL SURFACES SHOULD BE PERPENDICULAR TO EACH OTHER
NOTE: FINISH SIZE SHOULD BE 1.135" x 2.323" x 2.823"

8. CLEAN MACHINE

1. BRUSH SHAVINGS FROM MACHINE
2. WIPE MACHINE CLEAN
3. STORE ALL TOOLS IN PROPER PLACE ROUTE TO SURFACE GRINDER

SKETCH: DRAWING #3-A: SURFACE GAGE

REFERENCES: #3, PP. 209-225, #4, PP. 291-313, #5, PP. 197-209

IX-C-1(J)

JOB SHEET
ON
HORIZONTAL MILLING MACHINE

JOB: SURFACE GAGE

MATERIALS: PART #17: BASE - 1 3/8" x 2 1/2" x 3" 1020 MILD STEEL

TOOLS AND EQUIPMENT: HORIZONTAL MILLING MACHINE, MILLING MACHINE VISE, DIAL INDICATOR, ARBOR, SPACING COLLARS, 3" PLAIN MILLING CUTTER, COMBINATION SQUARE, 6" RULE, PARALLELS, LEAD HAMMER

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 229-283; REF. #4, PP. 317-405; REF. #5, PP. 223-298. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE.

NOTE: THIS IS AN ALTERNATE JOB WHICH MAY BE PERFORMED ON EITHER THE SHAPER, HORIZONTAL MILL, OR VERTICAL MILL. CHECK WITH INSTRUCTOR ON MACHINE SELECTION

NOTE: ALL TASKS WITH AN ASTERISK BY THEM ARE WRITTEN IN TASK FORM

PROCEDURE AND/OR TASK:

IX-C-1(TS)	CHECK HORIZONTAL MILL FOR PROPER OPERATING CONDITION
IX-C-1a(TS)	SET UP MILLING MACHINE ARBOR AND CUTTER
*IX-C-1b(TS)	MACHINE BASE SQUARE AND TO SIZE NOTE: HOLD DIMENSIONS .010" OVERSIZE FOR SURFACE GRINDING AS NOTED ON PRINT NO. 3-A
IX-C-1c(TS)	CLEAN MACHINE ROUTE TO SURFACE GRINDER

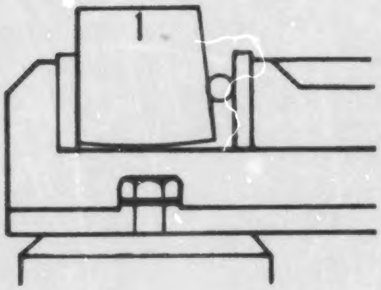
CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS.

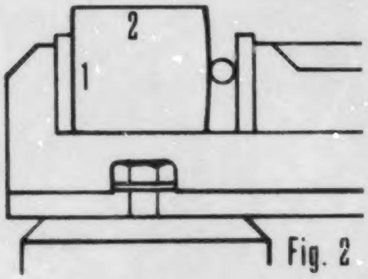
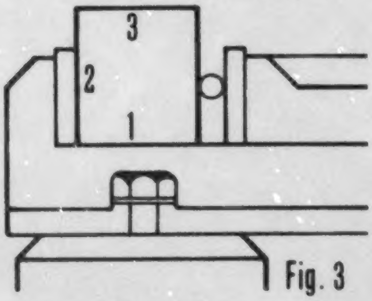
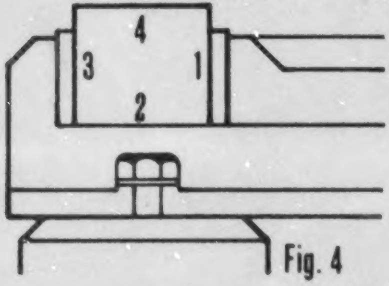
1. CHECK MACHINE FOR PROPER OPERATING CONDITIONS.
2. CHECK MACHINE FOR PROPER SETUP OF TOOLING AND VISE.
3. ALL DIMENSIONS HELD TO SPECIFICATIONS.
4. OBSERVANCE OF ALL SAFE WORKING HABITS.
5. CRAFTSMANLIKE PERFORMANCE AND APPLICATION FOR MACHINE TOOLS, EQUIPMENT, SUPPLIES, AND STANDARDS.

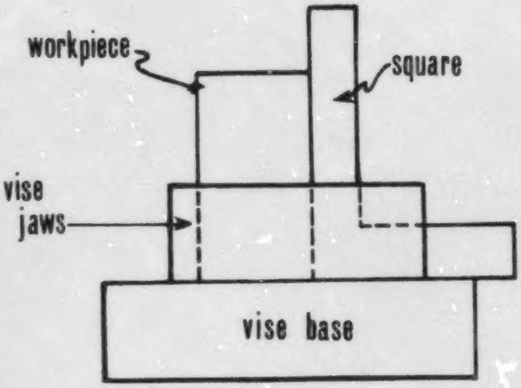
TASK SHEET IX-C-1b(TS)

TASK:	MACHINE BASE SQUARE AND TO SIZE
JOB:	SURFACE GAGE
TRADE:	MACHINIST
TOOLS AND EQUIPMENT:	HORIZONTAL MILLING MACHINE, MILLING MACHINE VISE, DIAL INDICATOR, 6" RULE, PARALLELS, 3" PLAIN MILLING CUTTER, ARBOR, SPACING COLLARS, COMBINATION SQUARE, LEAD HAMMER, ROUND ROD

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP MILLING MACHINE VISE	1. CHECK MILLING MACHINE BED FOR SHAVINGS, CHIPS, AND GENERAL CLEANLINESS 2. WIPE BASE OF VISE CLEAN 3. MOUNT VISE ON BED NOTE: VISE HANDLE DIRECTED TOWARD OPERATOR 4. TIGHTEN T-BOLT TO SECURE VISE TO BED 5. CHECK ALIGNMENT OF VISE JAW NOTE: USE DIAL INDICATOR
2. MACHINE FIRST SURFACE (FACE)  Fig. 1	1. SET WORKPIECE IN VISE NOTE: LARGEST SIDE FACE UP 2. PLACE WORKPIECE ON PARALLELS. REFER TO FIG. 1 NOTE: WIPE PARALLELS CLEAN NOTE: PLACE PAPER FEELER BETWEEN PARALLELS AND WORKPIECE 3. SNUG VISE AND TAP WORKPIECE LIGHTLY WITH LEAD HAMMER NOTE: CHECK PAPER FEELERS TO INSURE PROPER SEATING OF WORKPIECE 4. SET MILLING MACHINE SPEED AND FEED NOTE: ABOUT 60-90 SFM WITH ABOUT .004" TO .008" FEED 5. TURN MACHINE ON 6. LOWER MILLING CUTTER UNTIL CUTTER TOUCHES HIGH POINT ON WORKPIECE

STEPS	KEY POINTS
	NOTE: USE PAPER FEELER BETWEEN WORKPIECE AND PAPER 7. SET MICROMETER COLLAR ON "O" 8. MOVE BED TO CLEAR CUTTER 9. TURN VERTICAL HANDCRANK TO SET DEPTH OF CUT NOTE: REMOVE ONLY ENOUGH TO CLEAN UP FACE OF WORKPIECE 10. TURN MACHINE ON AND MACHINE FACE NOTE: USE CONVENTIONAL MILLING METHOD 11. REMOVE WORKPIECE AND BURR EDGES 12. WIPE VISE AND PARALLELS CLEAN
3. MACHINE SECOND SURFACE (FIRST EDGE)  Fig. 2	1. PLACE FIRST MACHINE AGAINST SOLID VISE JAW 2. PLACE ROUND ROD BETWEEN MOVABLE JAW AND WORKPIECE. REFER TO FIG. 2 3. ADJUST MILLING CUTTER UNTIL CONTACT WITH WORKPIECE IS MADE AS PER STEP #2 4. MACHINE SECOND SURFACE AS PER STEP #2 5. REMOVE WORKPIECE AND BURR EDGES 6. WIPE VISE AND PARALLEL CLEAN
4. MACHINE THIRD SURFACE (SECOND EDGE)  Fig. 3	1. PLACE FIRST MACHINED FACE AGAINST SOLID JAW 2. PLACE FIRST MACHINED EDGE AT THE BOTTOM OF VISE. REFER TO FIG. 3 3. PLACE ROUND ROD BETWEEN MOVABLE JAW AND NONMACHINED FACE 4. MACHINE THIRD SURFACE NOTE: ALLOW .010" OVERSIZE FOR SURFACE GRINDING. HOLD 2.323" 5. REMOVE WORKPIECE AND BURR EDGES 6. WIPE VISE CLEAN
5. MACHINE FOURTH SURFACE (SECOND EDGE)  Fig. 4	1. SET UP WORKPIECE. REFER TO FIG. 4 NOTE: WITH THREE FINISHED SURFACES, THE ROUND ROD WILL NOT BE REQUIRED CAUTION: POSITION WORKPIECE HIGH ENOUGH TO CLEAR VISE ON FINISH CUT 2. MACHINE WORKPIECE TO SIZE NOTE: ALLOW .010" FOR SURFACE GRINDING. HOLD 1.135"

STEPS	KEY POINTS
	3. REMOVE WORKPIECE AND BURR EDGES 4. CLEAN VISE
6. MACHINE FIRST END (FIFTH SURFACE)  Fig. 5	1. PLACE WORKPIECE ON ONE END IN THE VISE. REFER TO FIG. 5 NOTE: THE TWO MACHINED FACE SURFACES WILL BE PLACED AGAINST THE SOLID AND MOVABLE JAW 2. POSITION WORKPIECE IN VISE SO ONE EDGE EXTENDS OUT FROM VISE JAWS NOTE: PERMIT WORKPIECE TO EXTEND OUT ONLY ENOUGH TO CLEAR VISE JAWS 3. CHECK WORKPIECE EDGE WITH VISE BASE OR MILLING MACHINE TABLE FOR SQUARE NOTE: CHECK WITH SQUARE. REFER TO FIG. 5 NOTE: DIAL INDICATOR MAY BE USED 4. MACHINE END FOR CLEAN UP ONLY 5. REMOVE WORKPIECE AND BURR EDGES 6. CLEAN VISE
7. MACHINE SECOND END (SIXTH SURFACE)	1. PLACE NONMACHINED END UPRIGHT NOTE: PIECE WILL BE TURNED END FOR END FROM STEP #6. REFER TO FIG. 5 2. SQUARE EDGE AS PER STEP #6 3. MACHINE LENGTH OF WORKPIECE TO SIZE NOTE: ALLOW .010" FOR SURFACE GRINDING THE TWO ENDS. HOLD 2.823" LENGTH 4. REMOVE AND BURR EDGES 5. INSPECT WORKPIECE FOR SQUARE AND ACCURACY NOTE: ALL SURFACES SHOULD BE PERPENDICULAR TO EACH OTHER NOTE: FINISH SIZE SHOULD BE 1.135" x 2.323" x 2.823"
8. CLEAN MACHINE	1. BRUSH ALL SHAVINGS FROM MACHINE 2. WIPE MACHINE 3. REMOVE AND CLEAN ALL TOOLS AND STORE IN PROPER PLACE ROUTE TO SURFACE GRINDER

	STEPS	KEY POINTS
SKETCH:	DRAWING #3-A; SURFACE GAGE	
REFERENCES:	REF. #3, PP. 221-281 REF. #4, PP. 317-363 REF. #5, PP. 224-241	

X-B-1(J)

JOB SHEET
ON
SURFACE GRINDER

JOB: SURFACE GAGE

MATERIALS: PART #17: BASE, AS MACHINED SQUARE AND TO SIZE ON EITHER THE SHAPER OR MILLING MACHINE

TOOLS AND EQUIPMENT: SURFACE GRINDER, MAGNETIC CHUCK, DIAMOND WHEEL DRESSER, COMBINATION SQUARE, AND 6" RULE

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 287-298; REF. #4, PP. 434-445; REF. #5, PP. 338-347. CHECK WITH INSTRUCTOR UPON COMPLETION OF SETTING UP SURFACE GRINDER.

PROCEDURES AND/OR TASKS:

X-B-1(TS)	CHECK SURFACE GRINDER FOR PROPER OPERATING CONDITION
*X-B-1a(TS)	SET UP, TRUE GRINDING WHEEL, AND GRIND WORKPIECE TO FINISHED SIZE NOTE: HOLD 1 1/8" X 2 5/16" X 2 13/16" DIMENSIONS WITH ALL ADJACENT SURFACES PERPENDICULAR
X-B-1b(TS)	CLEAN AND SECURE SURFACE GRINDER ROUTE TO BENCH

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS.

1. PROPER OPERATION OF SURFACE GRINDER
2. GRINDING WHEEL TRUED AND PROPERLY DRESSED
3. CORRECT SETUP OF WORKPIECE
4. ALL DIMENSIONS AND FINISH HELD TO SPECIFICATIONS AND TOLERANCE
5. OBSERVANCE OF SAFE WORK HABITS
6. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT AND STANDARDS

TASK SHEET X-B-1a(TS)

TASK: SET UP, TRUE GRINDING WHEEL, AND GRIND WORKPIECE TO FINISHED SIZE

JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: SURFACE GRINDER, MAGNETIC CHUCK, DIAMOND WHEEL DRESSER, COMBINATION SQUARE, AND 6" RULE. PART #17: BASE AS MACHINED SQUARE AND TO SIZE

TASK BREAKDOWN:

STEPS	KEY POINTS
1. INSPECT AND MOUNT GRINDING	1. CHECK GRINDING WHEEL FOR CORRECT GRIT AND TYPE OF ABRASIVE
	2. CHECK OPERATING SPEED CAUTION: DO NOT EXCEED SAFE RATED OPERATIONAL SPEED
	3. INSPECT FOR CRACKS OR CHIPS IN WHEEL NOTE: TAP LIGHTLY WITH MALLET. SOUND SHOULD HAVE A CLEAR METALLIC RING
	4. INSERT CORRECT BUSHINGS
	5. CLEAN GRINDING WHEEL SLEEVE
	6. PLACE A WASHER BETWEEN THE WHEEL AND EACH CLAMPING FLANGE NOTE: WASHER MAY BE RUBBER, LEATHER, OR BLOTTING PAPER
	7. TIGHTEN SLEEVE NUT CAUTION: DO NOT OVER TIGHTEN
	8. SLIDE WHEEL SLEEVE ONTO SPINDLE
	9. SEAT WHEEL SLEEVE BY HAND
	10. ALIGN KEYWAY AND KEY IN THE SPINDLE
	11. DRAW SLEEVE TIGHT ON SPINDLE CAUTION: DO NOT OVER TIGHTEN NOTE: REFER TO MANUFACTURER'S MANUAL IF SETUP IS DIFFERENT
2. SET UP MAGNETIC CHUCK	1. WIPE BED OF GRINDER CLEAN
	2. WIPE UNDERSIDE OF MAGNETIC CHUCK CLEAN
	3. PLACE CHUCK ON BED OF GRINDER
	4. FASTEN MAGNETIC CHUCK TO BED WITH T-BOLTS

STEPS	KEY POINTS
3. TRUE AND DRESS GRINDING WHEEL	1. WIPE FACE OF MAGNETIC CHUCK CLEAN NOTE: USE CLEAN RAG AND PALM OF HAND
	2. CLEAN BASE OF DIAMOND HOLDER
	3. SET DIAMOND HOLDER ON MAGNET CHUCK NOTE: POSITION UNDER GRINDING WHEEL
	4. TURN MAGNET ON
	5. POSITION DIAMOND FOR DRESSING WHEEL
	6. TRUE AND DRESS GRINDING WHEEL NOTE: FOR ROUGH DRESSING OF WHEEL, LOWER GRINDING WHEEL .001" TO .002"; FOR FINISH DRESSING LOWER GRINDING WHEEL .0005" NOTE: LET GRINDING WHEEL SPARK OUT ON FINAL PASS
4. GRIND FIRST SURFACE	1. WIPE MAGNETIC CHUCK CLEAN NOTE: USE BOTH CLEAN RAG AND PALM OF HAND
	2. MOUNT WORKPIECE ON MAGNETIC CHUCK CAUTION: WORKPIECE MUST STRADDLE AS MANY ELECTROMAGNETIC INSERTS AS POSSIBLE
	3. SET TABLE FEED IF APPLICABLE
	4. SET TABLE DOGS
	5. TURN COOLANT ON IF APPLICABLE
	6. GRIND TO MINIMUM CLEANUP NOTE: APPROXIMATELY .005"
	7. REMOVE WORKPIECE AND BURR EDGES
5. GRIND SECOND SURFACE	1. WIPE MAGNETIC CHUCK CLEAN AS PER STEP #4
	2. MOUNT WORKPIECE ON MAGNETIC CHUCK AS PER STEP #4 NOTE: TURN WORKPIECE SO ADJACENT SIDE FROM PREVIOUS GROUND SURFACE IS FACE UP
	3. GRIND TO MINIMUM CLEANUP AS PER STEP #4
	4. REMOVE WORKPIECE AND BURR EDGES

STEPS	KEY POINTS
6. GRIND THIRD AND FOURTH SURFACES	AS PER STEPS #4 AND 5 NOTE: HOLD DIMENSIONS 1.125" AND 2.312"
7. GRIND TO LENGTH	1. MOUNT WORKPIECE ON MAGNETIC CHUCK WITH ONE END ON CHUCK NOTE: POSITION SO WORKPIECE STRADDLES AS MANY ELECTROMAGNETIC INSERTS AS POSSIBLE 2. GRIND END FOR MINIMUM CLEANUP AS PER STEP #4 3. REMOVE WORKPIECE AND BURR EDGES 4. WIPE CHUCK CLEAN 5. TURN WORKPIECE END FOR END NOTE: FINISHED END WILL BE MOUNTED 6. GRIND TO LENGTH. HOLD 2.812" 7. REMOVE WORKPIECE AND BURR EDGES 8. INSPECT FOR SIZE AND SQUARENESS 9. WIPE MAGNETIC CHUCK CLEAN 10. SECURE MACHINE AND TOOLS ROUTE TO BENCH

SKETCH: DRAWING #3-A SURFACE GAGE

REFERENCES: REF. #3, PP. 287-298
REF. #4, PP. 434-445
REF. #5, PP. 338-347

IV-C-1(J)

JOB SHEET
ON
BENCH

JOB:	SURFACE GAGE
MATERIALS:	PART #17: BASE, MACHINED AND SURFACE GROUND SQUARE AND TO SPECIFICATIONS
TOOLS AND EQUIPMENT:	LAYOUT TABLE, SCRIBE, LAYOUT INK, BALL PEEN HAMMER, PRICK PUNCH, COMBINATION SET, DIVIDER, HEIGHT GAGE OR SURFACE GAGE, CENTER PUNCH, AND 6' RULE
GENERAL INSTRUCTIONS:	BEFORE BEGINNING THIS JOB, READ REF. #3, PP. 57-65; REF. #4, PP. 51-61; REF. #5, PP. 53-63; REF. #1, PP. 62-72. CHECK WITH INSTRUCTOR UPON COMPLETION OF ALL LAYOUT WORK. A LAYOUT OF ALL LINES AND CENTERS WILL BE MADE PRIOR TO ANY MACHINING OPERATIONS. NOTE: AT THE INSTRUCTOR'S DISCRETION, HOLES MAY BE LAID OUT AND DRILLED PRIOR TO LAYOUT OF MILLING OPERATIONS NOTE: THOSE TASKS WITH AN ASTERISK BY THEM ARE WRITTEN OUT
PROCEDURE AND/OR TASK:	*IV-C-1(TS) LAY OUT CENTERS FOR HOLES *IV-C-1a(TS) LAY OUT GROOVES, SLOTS, AND ANGLES ROUTE TO DRILL PRESS
CHECK POINTS:	STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASK. 1. ALL LAYOUT LINES CLEAR AND DISTINCT. 2. ALL CENTERS LOCATED AND CENTER PUNCHED ACCURATELY. 3. ALL DIMENSIONS HELD TO SPECIFICATIONS AND TOLERANCE. 4. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS. 5. OBSERVANCE OF SAFE WORKING HABITS.

TASK SHEET

IV-C-1(TS)

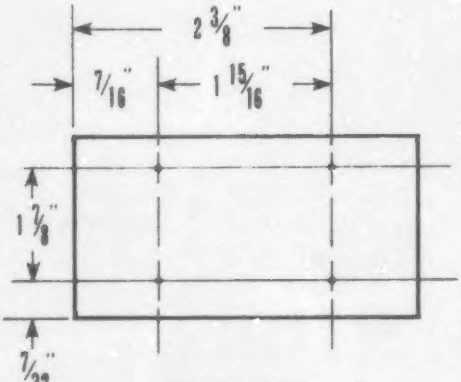
TASK: LAY OUT CENTERS FOR HOLES

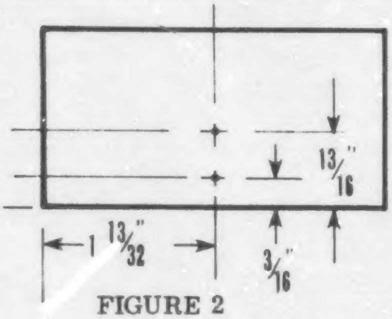
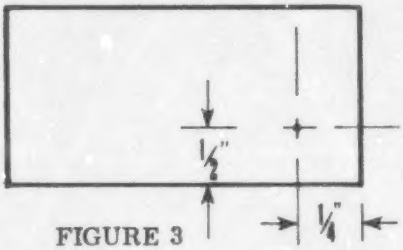
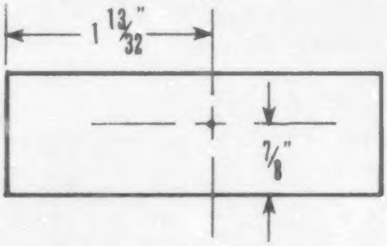
JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND EQUIPMENT: LAYOUT TABLE, SCRIBE, LAYOUT INK, BALL PEEN HAMMER, PRICK PUNCH, PROTRACTOR HEAD, COMBINATION SQUARE, DIVIDER, SURFACE GAGE OR HEIGHT GAGE, CENTER PUNCH, AND 6" RULE, PART #17 - BASE AS MACHINED SQUARE ON EITHER SHAPER OR MILLING MACHINE

TASK BREAKDOWN:

STEPS	KEY POINTS
1. LAY OUT CENTERS FOR 11/64" HOLES  FIGURE 1	1. INK TOP FACE OF BASE WITH LAYOUT INK 2. SCRIBE LINE PARALLEL TO FRONT EDGE 7/32" FROM FRONT EDGE 3. SCRIBE LINE PARALLEL TO FRONT EDGE 2 3/32" FROM FRONT EDGE NOTE: DISTANCE BETWEEN THE TWO LINES WILL BE 1 7/8" AS PER DRAWING 4. SCRIBE LINE PARALLEL TO LEFT EDGE 7/16" FROM LEFT EDGE NOTE: INTERSECTION OF LINES WILL BE THE CENTER FOR THE TWO 11/64" HOLES ON THE LEFT SIDE 5. SCRIBE LINE PARALLEL TO LEFT EDGE 2 3/8" FROM LEFT EDGE NOTE: INTERSECTION OF LINES WILL LOCATE THE CENTERS FOR THE TWO 11/64" HOLES ON THE RIGHT SIDE NOTE: THE DISTANCE BETWEEN CENTERS WILL BE 1 15/16" 6. CHECK LAYOUT FOR ACCURACY 7. LOCATE CENTERS WITH PRICK PUNCH
2. LAY OUT CENTERS FOR #36 DRILL - 6-32 N.C. HOLE - 2 HOLES	1. SCRIBE LINE PARALLEL TO FRONT EDGE 3/16" FROM EDGE 2. SCRIBE LINE PARALLEL TO FRONT EDGE 13/16" FROM EDGE NOTE: DISTANCE BETWEEN TWO LINES WILL BE 5/8" 3. SCRIBE LINE PARALLEL TO LEFT EDGE 1 13/32" FROM EDGE

STEPS	KEY POINTS
 FIGURE 2	NOTE: INTERSECTION OF LINES WILL LOCATE THE CENTER OF THE TWO HOLES 4. CHECK LAYOUT FOR ACCURACY 5. LOCATE CENTERS WITH PRICK PUNCH
3. LAY OUT CENTER FOR 17/64" HOLE  FIGURE 3	1. SCRIBE LINE PARALLEL TO FRONT EDGE 1/2" FROM EDGE 2. SCRIBE LINE PARALLEL TO RIGHT EDGE 1/4" FROM EDGE NOTE: INTERSECTION WILL BE CENTER LOCATION 3. CHECK LAYOUT FOR ACCURACY 4. LOCATE CENTER WITH PRICK PUNCH
4. LAY OUT CENTER FOR #I DRILLED HOLE NOTE: THIS WILL ALSO BE THE CENTER FOR 21/64" DRILLED HOLE  FIGURE 4	1. TURN WORKPIECE SO THE FRONT FACE IS UPRIGHT CAUTION: DO NOT POSITION WORKPIECE BY TURNING ENDS AROUND 2. SCRIBE LINE PARALLEL TO BOTTOM EDGE 7/8" FROM BOTTOM EDGE 3. SCRIBE LINE PARALLEL TO LEFT EDGE 1 13/32" FROM LEFT EDGE NOTE: CENTER LINE SHOULD COINCIDE WITH CENTER LINE SCRIBED IN STEP 2 KEY POINT 3 4. CHECK LAYOUT FOR ACCURACY 5. LOCATE CENTER WITH PRICK PUNCH NOTE: HOLES MAY BE DRILLED PRIOR TO COMPLETION OF LAYOUT

SKETCHES: DRAWING #3-A: SURFACE GAGE

REFERENCES:
#3, PP. 57-65
#4, PP. 51-61
#5, PP. 53-63
#1, PP. 62-72

TASK SHEET

IV-C-1a(TS)

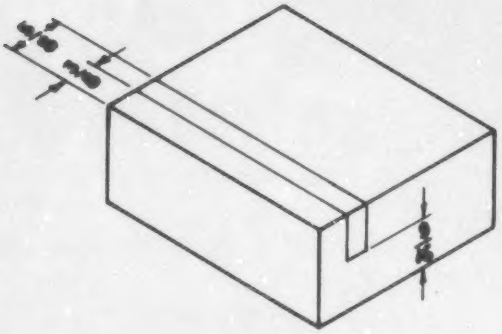
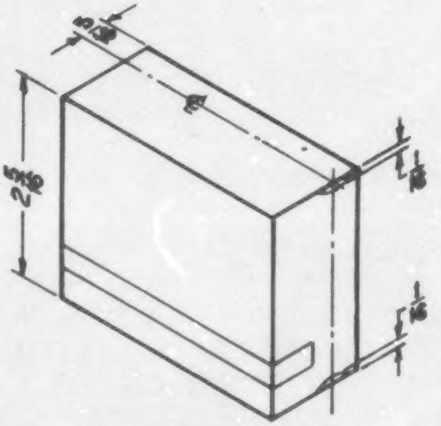
TASK: LAY OUT GROOVES, SLOTS, AND ANGLES

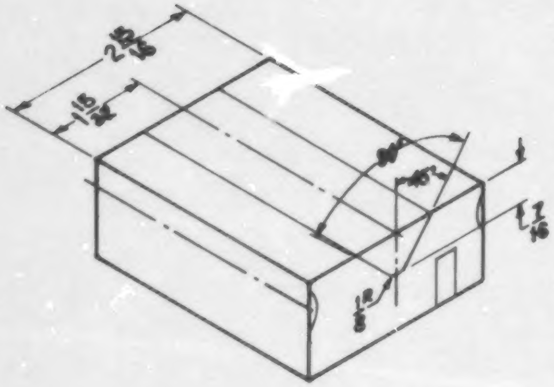
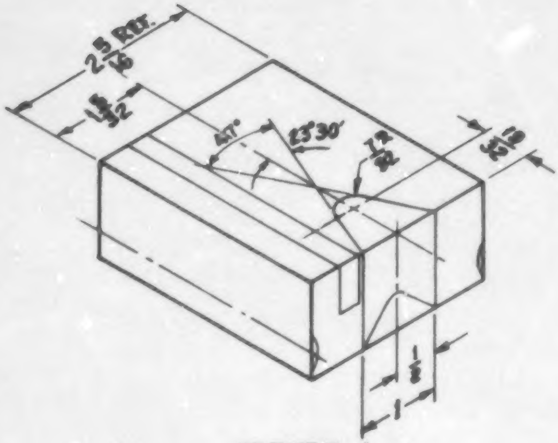
JOB: SURFACE GAGE

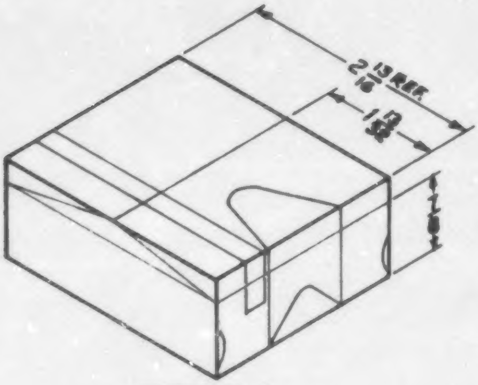
TRADE: MACHINIST

TOOLS AND MATERIALS: LAYOUT TABLE, HEIGHT GAGE OR SURFACE GAGE, LAYOUT INK, 6" RULE, DIVIDERS, PRICK PUNCH, AND BALL PEEN HAMMER

TASK BREAKDOWN:

STEPS	KEY POINTS
1. LAY OUT 1/4" GROOVE	1. PLACE WORKPIECE ON LAYOUT TABLE WITH TOP FACE UPRIGHT SEE FIG. 1 2. SCRIBE A LINE PARALLEL TO FRONT EDGE 3/8" FROM FRONT EDGE 3. SCRIBE A LINE PARALLEL TO FRONT EDGE 5/8" FROM FRONT EDGE **NOTE:** THE TWO SCRIBED LINES WILL BE 1/8" FROM THE CENTER LINE OF THE 17/64" DRILLED HOLE LAID OUT IN IV-C-1 (TS) 4. LAY OUT DEPTH OF SLOT ON RIGHT END OF WORKPIECE **NOTE:** DEPTH IS MEASURED 9/16" FROM BOTTOM WORKPIECE
 FIGURE 1	
2. LAY OUT 3/8"R GROOVES - 2	1. TURN WORKPIECE ON BACK FACE **NOTE:** FRONT FACE WILL BE UPRIGHT 2. SCRIBE LINE PARALLEL TO TOP AND BOTTOM EDGE 5/16" FROM BOTTOM EDGE REFER TO FIGURE 2 **NOTE:** THIS WILL BE THE CENTER LINE OF 3/8"R GROOVE 3. ON RIGHT END FACE SCRIBE LINE PARALLEL TO FRONT AND BACK EDGE 1/16" FROM FRONT EDGE 4. TURN WORKPIECE SO BACK FACE WILL BE UPRIGHT **NOTE:** FRONT FACE WILL BE ON LAYOUT TABLE 5. LAY OUT SECOND GROOVE AS PER FIRST GROOVE
 FIGURE 2	

STEPS	KEY POINTS
3. LAY OUT 90° GROOVE  FIGURE 3  2 5/16 REF. 1 5/32 47° 23°30' 7/32 R 13/32 1/8 1 FIGURE 4	1. PLACE WORKPIECE ON LAYOUT TABLE TOP FACE DOWN REFER TO FIGURE 3 NOTE: FRONT FACE WILL BE TOWARD STUDENT 2. SCRIBE CENTER LINE OF GROOVE PARALLEL TO FRONT EDGE 1 5/32" FROM EDGE 3. SCRIBE TWO LINES ON EACH SIDE OF AND PARALLEL TO THE CENTER LINE 1/2" FROM THE CENTER LINE NOTE: THIS REPRESENTS THE WIDTH OF THE GROOVE 4. TURN WORKPIECE 90° SO THE RIGHT END FACE IS UP RIGHT NOTE: FRONT FACE WILL BE TOWARD STUDENT 5. PROJECT THE LINES FROM BOTTOM FACE ONTO THE END FACE 6. SCRIBE 45° LINES FROM LINES FORMING THE WIDTH NOTE: 45° LINES WILL INTERSECT ON THE CENTER LINE 7. LAY OUT DEPTH OF GROOVE BY SCRIBING LINE PARALLEL TO BOTTOM FACE 7/16" FROM BOTTOM EDGE 8. LOCATE CENTER OF 1/8"R ON CENTER LINE OF GROOVE NOTE: CENTER WILL BE 5/16" FROM BOTTOM EDGE 9. SCRIBE 1/8"R NOTE: RADIUS SHOULD BE TANGENT TO 45° LINES AND DEPTH OF GROOVE LINE 10. LAY OUT OTHER END THE SAME WAY
4. LAY OUT 7/32"R GROOVE (47° ANGLE)	1. PLACE WORKPIECE ON LAYOUT TABLE WITH TOP FACE UPRIGHT SEE FIG. 4 NOTE: FRONT FACE TOWARD STUDENT 2. SCRIBE CENTER LINE PARALLEL TO FRONT EDGE 1 5/32" FROM FRONT EDGE 3. LAY OUT WIDTH OF GROOVE BY SCRIBING TWO LINES 1/2" FROM CENTER LINE AND PARALLEL TO CENTER LINE NOTE: LAYOUT LINES ON THE END WILL COINCIDE WITH LAYOUT LINES OF 90° GROOVE

STEPS	KEY POINTS
	4. LOCATE CENTER OF 7/32"^{R} BY SCRIBING LINE PARALLEL TO RIGHT EDGE 5. SCRIBE 7/32" RADIUS 6. SCRIBE LINES FROM WIDTH LAYOUT LINES TANGENT TO 7/32" RADIUS NOTE: THE TWO LINES ARE AT AN ANGLE OF 23° 30' FORMING A 47° GROOVE
5. LAY OUT 10° ANGULAR SURFACES ON TOP FACE  FIGURE 5	1. WORKPIECE POSITIONED ON LAYOUT TABLE WITH FRONT FACE UPRIGHT 2. LAY OUT INTERSECTION OF THE TWO INCLINED SURFACES REFER TO FIG. 5 NOTE: INTERSECTION WILL BE THE PREVIOUSLY SCRIBED C_L FOR #36 DRILLED HOLE 3. SCRIBE LINE PARALLEL TO BOTTOM FACE 7/8" FROM BOTTOM EDGE ON THE FRONT FACE 4. SCRIBE INCLINED LINES FROM ENDS INTERSECTING AT CENTER LINE ROUTE TO DRILL PRESS

SKETCHES: DRAWING #3-A, SURFACE GAGE

REFERENCES:
REF. #3, PP. 57-65
REF. #4, PP. 51-61
REF. #5, PP. 53-63
REF. #1, PP. 62-72

JOB SHEET
ON
DRILL PRESS

VI-C-1 (J)

JOB: SURFACE GAGE

MATERIALS: PART #17: BASE AS MACHINED AND SURFACE GROUND TO SIZE COMPLETE WITH LAYOUT OF ALL HOLES, SLOTS, AND GROOVES

TOOLS AND EQUIPMENT: DRILL PRESS, DRILL PRESS VISE, 11/64" DRILL, .188" (3/16") REAMER, 17/64" DRILL, NO. "T" DRILL, 21/64" COREDRILL OR COUNTERBORE, NO. "36" DRILL, AND COMBINATION SQUARE OR SURFACE GAGE

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB, READ REF. #3, PP. 95-115; REF. #4, PP. 185-210; REF. #5, PP. 117-135; REF. #2, PP. 213-223. CHECK WITH INSTRUCTOR UPON COMPLETION OF ALL DRILLING OPERATIONS.

NOTE: AT INSTRUCTOR'S DISCRETION, HOLES TO BE TAPPED MAY BE DONE SO IMMEDIATELY UPON THE DRILLING OF THE HOLES EITHER ON THE DRILL PRESS OR AT THE BENCH.

PROCEDURE AND/OR TASK:

VI-C-1(TS)	CHECK DRILL PRESS FOR PROPER OPERATING CONDITION
VI-C-1a(TS)	SET UP DRILL PRESS VISE AND WORKPIECE
*VI-C-1b(TS)	SET UP, DRILL, REAM, AND COUNTERDRILL ALL HOLES

NOTE: DRILL 4 HOLES 11/64" AND REAM .188 THRU
DRILL 2 HOLES NO. "36" - 5/16" DEEP
DRILL 1 HOLE 17/64" - 15/16" DEEP
DRILL 1 HOLE NO. "I" THROUGH FROM BACK SIDE AND COUNTERDRILL 21/64" - 1 9/32" DEEP

ROUTE TO BENCH

CHECK POINTS: STUDENT TO CONFER WITH THE INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS.

1. PROPER OPERATION OF DRILL PRESS
2. CORRECT SELECTION AND INSPECTION OF DRILLS
3. CORRECT SETUP OF WORKPIECE
4. OBSERVANCE OF ALL SAFETY PROCEDURES
5. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS

TASK SHEET VI-C-1b(TS)

TASK:	SET UP, DRILL, REAM, AND COUNTERDRILL ALL HOLES
JOB:	SURFACE GAGE
TRADE:	MACHINIST
TOOLS AND MATERIALS:	DRILL PRESS, DRILL PRESS VISE, 11/64" DRILL, .188" (3/16") REAMER, 17/64" DRILL. NO. "36" DRILL, NO. "I" DRILL, 21/64" COREDRILL OR COUNTERBORE, AND COMBINATION SQUARE. PART #17: BASE AS MACHINED, SURFACE GROUND TO SIZE, AND ALL HOLES, SLOTS, AND GROOVES LAID OUT

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP WORKPIECE	1. MOUNT WORKPIECE IN VISE WITH TOP FACE UP NOTE: INSPECT VISE FOR SHAVINGS, DIRT, AND NICKS 2. CHECK TO SEE THAT WORKPIECE IS IN VISE LEVEL 3. TIGHTEN VISE FIRMLY 4. POSITION LAYOUT OF FIRST HOLE DIRECTLY UNDER DRILL NOTE: FOR THE SIZE DRILLS TO BE USED, BOLTING THE VISE TO THE TABLE WILL NOT BE REQUIRED
2. INSTALL 11/64" DRILL IN DRILL SPINDLE	1. SELECT CORRECT DRILL SIZE 2. INSPECT DRILL FOR CONDITION 3. INSTALL DRILL CHUCK (IF NECESSARY) 4. INSERT DRILL INTO CHUCK AND TIGHTEN FIRMLY 5. CHECK DRILL FOR RUNNING TRUE
3. DRILL 11/64" HOLES	1. SET SPINDLE SPEED NOTE: REFER TO DRILL SPEED CHART 2. SET SPINDLE FEED IF APPLICABLE 3. LUBRICATE DRILL 4. DRILL HOLE THRU CAUTION: DO NOT APPLY TOO MUCH PRESSURE ON FEED TO AVOID DRILL BREAKAGE 5. DRILL ALL FOUR HOLES 6. REMOVE DRILL 7. INSPECT HOLES

STEPS	KEY POINTS
4. REAM .188" HOLES	1. SELECT .188" REAMER 2. INSPECT FOR CONDITION 3. INSTALL REAMER AS PER 11/64" DRILL IN STEP #2 4. ALIGN REAMER WITH HOLE 5. SET SPINDLE SPEED NOTE: SPEED APPROXIMATELY 1/2 TO 2/3 OF DRILLING SPEED 6. REAM ALL 4 HOLES NOTE: FEED SHOULD BE TWO TO THREE TIMES AS GREAT AS DRILLING FEED NOTE: KEEP LUBRICATED 7. CUT OFF DRILL AND INSPECT HO[illegible] 8. REMOVE REAMER FROM CHUCK
5. DRILL TWO HOLES WITH #36 DRILL	1. SELECT #36" DRILL 2. INSPECT FOR CONDITION 3. INSTALL DRILL AS PER 11/64" DRILL IN STEP #2 4. LOCATE DRILL WITH LAYOUT 5. SET SPINDLE SPEED AND FEED 6. DRILL TO 5/16" DEPTH NOTE: KEEP DRILL LUBRICATED 7. INSPECT HOLES 8. REMOVE DRILL
6. DRILL 17/64" HOLE	1. SELECT 17/64" DRILL 2. INSPECT FOR CONDITION 3. INSTALL DRILL AS PER 11/64" DRILL IN STEP #2 4. LOCATE DRILL WITH LAYOUT 5. SET SPINDLE SPEED AND FEED 6. DRILL TO 15/16" DEPTH NOTE: SLOT WILL BE MACHINED LATER 7. INSPECT HOLE 8. REMOVE DRILL
7. SET UP AND DRILL NO. "I" HOLE	1. SET UP WORKPIECE AS PER STEP #1 NOTE: BACK FACE WILL BE FACE UP 2. SELECT NO. "I" DRILL 3. INSPECT FOR CONDITION 4. SET SPINDLE SPEED AND FEED 5. LOCATE DRILL WITH LAYOUT 6. DRILL HOLE ALL THE WAY THROUGH NOTE: LUBRICATE DRILL

STEPS	KEY POINTS
	7. INSPECT HOLE 8. REMOVE DRILL
8. COUNTERDRILL HOLE WITH 21/64" COREDRILL	1. SELECT 21/64" COREDRILL NOTE: COUNTERBORE MAY BE USED 2. INSPECT FOR CONDITION 3. SET SPINDLE SPEED AND FEED 4. LOCATE DRILL WITH HOLE NOTE: UNLESS TABLE OR VISE WAS MOVED THE DRILL AND HOLE SHOULD BE ALIGNED 5. COUNTERDRILL HOLE TO DEPTH NOTE: HOLD 1 9/32" DEEP 6. INSPECT HOLE 7. REMOVE DRILL
9. SECURE DRILL PRESS	1. REMOVE ALL TOOLING FROM DRILL PRESS 2. WIPE ALL TOOLS CLEAN 3. BRUSH AND WIPE DRILL TABLE CLEAN 4. CLEAN AREA AROUND DRILL PRESS 5. RETURN ALL TOOLS TO PROPER STORAGE ROUTE TO BENCH

SKETCH: DRAWING #3-A SURFACE GAGE

REFERENCES:
REF. #2, PP. 213-223
REF. #3, PP. 95-115
REF. #4, PP. 185-210
REF. #5, PP. 117-135

IV-C-2(J)

JOB SHEET
ON
BENCH

JOB:	SURFACE GAGE
MATERIALS:	PART #17: BASE AS MACHINED AND SURFACE GROUND, LAYOUT OF ALL SLOTS AND GROOVES MADE, AND ALL HOLES DRILLED
TOOLS AND EQUIPMENT:	WORK BENCH, BENCH VISE WITH VISE JAW PROTECTIVE CAPS, TAP WRENCH, #6-32 N.C. TAPER AND BOTTOM TAP, 5/16" - 24 N.F. TAPER AND BOTTOM TAP, AND COMBINATION SQUARE
GENERAL INSTRUCTIONS:	BEFORE BEGINNING THIS JOB READ REF. #2, PP. 241-245; REF. #3, PP. 84-90; REF. #4, PP. 117-121; REF. #5, PP. 72-74; CHECK WITH INSTRUCTOR UPON COMPLETION OF THREADING OPERATION

PROCEDURES AND/OR TASKS:

IV-C-2(TS)	SET UP WORK BENCH FOR TAPPING
* IV-C-2a(TS)	TAP ALL REQUIRED HOLES NOTE: 2 HOLES 6-32 N.C. THRU 1 HOLE 5/16" - 24 N.F. THRU
	ROUTE TO MILLING MACHINE

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS.

1. BENCH VISE SETUP WITH SOFT JAW CAPS
2. PROPER SELECTION OF TAP
3. THREADED HOLE SQUARE WITH WORKPIECE
4. HOLES TAPPED TO PROPER DEPTH
5. THREADS CUT SMOOTH AND CLEAN

TASK SHEET IV-C-2a(TS)

TASK:	TAP ALL REQUIRED HOLES
JOB:	SURFACE GAGE
TRADE:	MACHINIST
TOOLS AND MATERIALS:	WORK BENCH, BENCH VISE, VISE JAW PROTECTOR CAPS, TAP WRENCH, #6-32N.C. TAPER AND BOTTOM TAP, 5/16" 24 N.F. TAPER AND BOTTOM TAP, AND COMBINATION SQUARE. PART #17: BASE AS MACHINED AND SURFACE GROUND TO SIZE, LAYOUT OF ALL SLOTS, AND GROOVES MADE, AND ALL HOLES DRILLED

TASK BREAKDOWN:

STEPS	KEY POINTS
1. MOUNT WORKPIECE IN BENCH VISE	1. PLACE VISE JAW CAPS ON VISE JAWS
	2. PLACE WORKPIECE IN VISE NOTE: TOP FACE WILL BE POSITIONED UP
	3. TIGHTEN VISE JAW FIRMLY NOTE: SHOULD VISE BE OF SWIVEL TYPE, POSITION VISE IN MOST CONVENIENT POSITION AND LOCK SWIVEL LOCK
2. TAP 2 HOLES 6-32 N.C.	1. SELECT 6-32 N.C. TAPER AND BOTTOM TAP
	2. INSPECT FOR CONDITION
	3. FASTEN TAPER TAP IN TAP WRENCH
	4. APPLY CUTTING FLUID TO TAP
	5. PLACE TAP IN THE HOLE IN A VERTICAL POSITION
	6. APPLY FIRM PRESSURE DOWNWARD WHILE TURNING TAP WRENCH SLOWLY CLOCKWISE
	7. TURN TAP ABOUT TWO TURNS NOTE: TURN UNTIL TAP IS STARTED
	8. REMOVE TAP WRENCH CAREFULLY
	9. CHECK TAP FOR SQUARENESS NOTE: CHECK AT TWO POSITIONS 90° TO EACH OTHER NOTE: IF TAP IS NOT STARTED SQUARE REMOVE TAP FROM HOLE AND RESTART IT BY APPLYING PRESSURE IN THE DIRECTION FROM WHICH THE TAP LEANS

STEPS	KEY POINTS
	10. FEED TAP INTO HOLE BY CONTINUING TO TURN CLOCKWISE CAUTION: REVERSE DIRECTION APPROXIMATELY EVERY ONE-TWO TURNS TO BREAK CHIPS LOOSE
	11. CONTINUE UNTIL TAP BOTTOMS ON "I" DRILLED HOLE
	12. BACK TAP OUT
	13. REPLACE TAP WITH BOTTOM TAP
	14. RECHASE THREAD UNTIL TAP BOTTOMS ON "I" DRILLED HOLE
	15. REMOVE TAP AND REPEAT STEPS IN TAPPING SECOND HOLE
3. TAP 5/16 - 24 N.F. HOLE	1. LOOSEN VISE AND REMOVE WORKPIECE
	2. TURN WORKPIECE SO FRONT FACE WILL BE POSITIONED UP
	3. FASTEN IN VISE AS PER STEP #1
	4. SELECT 5/16 - 24 N.F. TAPER TAP
	5. INSPECT TAP
	6. THREAD HOLE AS PER STEP #2 NOTE: THREAD WITH TAPER TAP FIRST AND FINISH WITH BOTTOM TAP
	7. REMOVE TAP
	8. INSPECT THREADS
	9. SECURE WORK AREA
	10. CLEAN AND STORE TOOLS IN PROPER PLACE
	ROUTE TO MILLING MACHINE

SKETCH: DRAWING #3-A SURFACE GAGE

REFERENCES: REF. #2, PP. 241-245
REF. #3, PP. 84- 90
REF. #4, PP. 117-121
REF #5, PP. 72- 74

IX-C-2(J)

JOB SHEET
ON
VERTICAL MILLING MACHINE

JOB: SURFACE GAGE

MATERIALS: PART #17: BASE AS MACHINED SQUARE AND TO SIZE, LAYOUT OF ALL SLOTS AND GROOVES MADE, AND ALL HOLES DRILLED AND TAPPED

TOOLS AND EQUIPMENT: VERTICAL MILLING MACHINE, UNIVERSAL VISE, 1/4" END MILL HOLDER, 1/4" END MILL WITH SPHERICAL RADIUS, 7/16" END MILL HOLDER, 7/16" END MILL WITH SPHERICAL RADIUS, 3/4" END MILL HOLDER, 3/4" END MILL SPHERICAL RADIUS, 1 1/2" SHELL MILL, SHELL MILL ADAPTOR, 1/4" END MILL (NO RADIUS), DIAL INDICATOR, DEPTH MICROMETER, BEVEL PROTRACTOR, PARALLEL BARS, 6" RULE, AND MILL FILE

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 229-276; REF. #4, PP. 317-366; REF. #5, 223-240, 285-290

PROCEDURES AND/OR TASKS:

IX-A-1(TS)	CHECK VERTICAL MILLING MACHINE FOR PROPER OPERATING CONDITION
*IX-C-2(TS)	MILL 90° VEE GROOVE WITH 1/8"^{R}
*IX-C-2a(TS)	MILL 3/8" RADIUS GROOVE NOTE: BOTH FRONT AND BACK SIDE
*IX-C-2b(TS)	MILL VEE GROOVE WITH 7/32"^{R}
*IX-C-2c(TS)	MILL 10°5' ANGLE ON TOP FACE
*IX-C-2d(TS)	MILL 1/4" SLOT NOTE: HOLD 9/16" FROM BOTTOM
IX-A-1c(TS)	CLEAN MACHINE ROUTE TO SURFACE GRINDER

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS.

1. PROPER OPERATION OF VERTICAL MILLING MACHINE
2. CHECK MACHINE FOR PROPER SETUP OF TOOLING AND VISE
3. ALL DIMENSIONS HELD TO SPECIFICATIONS
4. OBSERVANCE OF ALL SAFE WORKING HABITS
5. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR MACHINE TOOLS, EQUIPMENT, SUPPLIES, AND STANDARDS

TASK SHEET IX-C-2(TS)

TASK:	MILL 90° VEE GROOVE WITH 1/8"R
JOB:	SURFACE GAGE
TRADE:	MACHINIST
TOOLS AND MATERIALS:	VERTICAL MILLING MACHINE, UNIVERSAL VISE, 1/4" END MILL HOLDER, 1/4" END MILL WITH SPHERICAL RADIUS, DEPTH MICROMETER, LEAD HAMMER, DIAL INDICATOR, PARALLELS, 3/4" END MILL AND 3/4" END MILL HOLDER. PART #17: BASE AS MACHINED SQUARE AND TO SIZE, WITH LAYOUT FOR ALL GROOVES AND SLOTS MADE, AND ALL HOLES DRILLED AND TAPPED

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP 1/4" END MILL	1. SELECT AND INSPECT 1/4" END MILL NOTE: END MILL TO HAVE 1/8" SPHERICAL RADIUS 2. INSTALL 1/4" END MILL HOLDER 3. INSTALL 1/4" END MILL NOTE: CHECK FOR RUNNING TRUE
2. SET UP UNIVERSAL VISE	1. WIPE MILLING MACHINE TABLE CLEAN 2. WIPE BASE OF VISE CLEAN 3. MOUNT UNIVERSAL VISE ON TABLE NOTE: VISE JAWS ARE PARALLEL TO TABLE NOTE: FASTEN VISE TO TABLE WITH T-BOLTS 4. ALIGN VISE JAWS WITH DIRECTION OF FEED NOTE: USE DIAL INDICATOR
3. SET UP WORKPIECE	1. WIPE INSIDE OF VISE AND VISE JAWS CLEAN 2. MOUNT WORK ON PARALLELS IN VISE NOTE: THE BOTTOM FACE WITH THE 90° VEE GROOVE LAYOUT WILL BE FACE UP WITH CENTER AXIS OF GROOVE PARALLEL TO VISE JAWS. SEE FIG. 1 3. LEVEL WORKPIECE NOTE: CHECK WITH DIAL INDICATOR 4. TIGHTEN VISE FIRMLY NOTE: RECHECK WITH DIAL INDICATOR

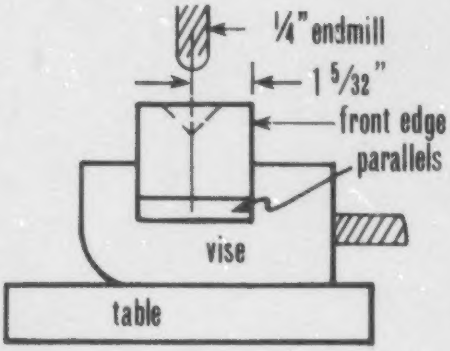
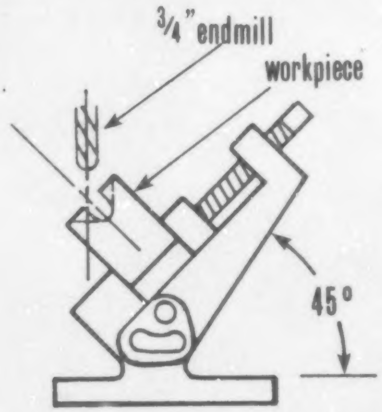


Fig. 1

STEPS	KEY POINTS
4. MILL 1/8"^{R}	1. RAISE TABLE UNTIL END MILL MAKES CONTACT WITH WORKPIECE 2. SET GRADUATED FEED COLLAR ON THE VERTICAL FEED TO ZERO 3. SET SPINDLE SPEED AND TABLE FEED. REFER TO CUTTING SPEED AND FEED CHART 4. MILL SLOT TO 7/16" DEPTH NOTE: SLOT WILL BE 1/4" WIDE WITH A 1/8"^{R} AT BOTTOM CENTERED 1 5/32" FROM EDGE 5. BURR EDGES
5. MILL VEE GROOVE  Fig 2	1. CLEAR WORKPIECE FROM END MILL 2. SET VISE AT 45° ANGLE TO HORIZONTAL PLANE REFER TO FIG. 2 3. INSTALL 3/4" END MILL 4. SET SPINDLE SPEED AND FEED 5. MILL GROOVE TO LAYOUT LINES NOTE: DO NOT CUT INTO THE 1/8" RADII. THE ANGLE CUTS SHOULD BLEND INTO THE RADIUS CUT NOTE: HOLD 1" WIDTH ON FACE OF ANGLE 21/32" FROM THE EDGE 6. BURR EDGES 7. REMOVE WORKPIECE FROM VISE 8. INSPECT WORKPIECE 9. REMOVE END MILL AND SECURE MACHINE

SKETCHES: DRAWING #3-A: SURFACE GAGE

REFERENCES: REF. #3, PP. 229-276
REF. #4, PP. 317-366
REF. #5, PP. 223-240, 285-290

TASK SHEET IX-C-2a(TS)

TASK: MILL 3/8" RADIUS GROOVE - 2 SIDES

JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: VERTICAL MILLING MACHINE, UNIVERSAL VISE, 3/4" BALL-END END MILL, 6" RULE, DIAL INDICATOR, PARALLELS, LEAD HAMMER, 3/4" END MILL HOLDER, DEPTH MICROMETER, MILL FILE AND PART #17: BASE AS MACHINED IN PREVIOUS TASKS

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP 3/4" BALL-END END MILL	1. SELECT AND INSPECT 3/4" BALL-END END MILL NOTE: END MILL WILL HAVE 3/8" SPHERICAL RADIUS 2. INSTALL END MILL INTO END MILL HOLDER NOTE: HOLDER WILL HAVE BEEN INSTALLED FOR STEP #5, IX-C-2(TS) 3. CHECK END MILL FOR RUNNING TRUE
2. SET UP UNIVERSAL VISE	1. MOUNT VISE ON TABLE AS PER STEP #2, IX-C-2(TS) NOTE: VISE SHOULD REMAIN IN POSITION ON TABLE UPON COMPLETION OF TASK IX-C-2(TS) 2. LOOSEN VERTICAL ELEVATION LOCK SCREWS 3. POSITION VISE AT 0° NOTE: BOTTOM OF VISE WILL BE IN HORIZONTAL POSITION 4. TIGHTEN LOCKS SCREWS FIRMLY NOTE: CHECK BASE OF VISE FOR TRUENESS WITH DIAL INDICATOR
3. SET UP WORKPIECE	1. CLEAN VISE AND PARALLELS 2. MOUNT WORKPIECE ON PARALLELS IN VISE NOTE: FRONT FACE WILL BE FACE UP WITH BOTTOM FACE TOWARD OPERATOR 3. TRUE WORKPIECE

STEPS	KEY POINTS
	NOTE: CHECK WORKPIECE WITH DIAL INDICATOR ALONG TOP FACE AND SIDE FOR TRUENESS AND PARALLELISM 4. TIGHTEN VISE FIRMLY NOTE: RECHECK WITH DIAL INDICATOR
4. MILL 3/8"^{R} GROOVE ON FRONT FACE	1. POSITION 3/4" BALL-END MILL NOTE: END MILL WILL BE POSITIONED 5/16" ON CENTER FROM BOTTOM EDGE AS PER DRAWING NO. 3-A 2. RAISE TABLE UNTIL CONTACT IS MADE BY THE END MILL ON THE WORKPIECE 3. SET GRADUATED FEED COLLAR ON THE VERTICAL FEED AT ZERO 4. SET SPINDLE SPEED AND TABLE FEED NOTE: REFER TO REFERENCE CHART 5. RAISE TABLE .0625" 6. MILL GROOVE TO .0625" SPECIFIED DEPTH NOTE: HOLD CENTER OF GROOVE 5/16" FROM BOTTOM EDGE 7. CLEAR END MILL 8. BURR EDGES AND INSPECT 9. REMOVE WORKPIECE FROM VISE
5. MILL 3/8^{R} GROOVE ON BACK FACE	FOLLOW SAME PROCEDURE AS IN STEPS #1 - 4 FOR MILLING GROOVE ON FRONT FACE NOTE: THE TWO GROOVES WILL BE PARALLEL AND ALL SPECIFICATIONS WILL BE THE SAME CAUTION: USE THE BOTTOM EDGE AS REFERENCE FOR LOCATING THE END MILL AS IN PREVIOUS STEPS
6. CLEAN MACHINE	1. REMOVE WORKPIECE, BURR, AND INSPECT 2. CLEAN VISE AND MACHINE 3. STORE ALL TOOLS IN PROPER STORAGE

SKETCHES: DRAWING #3-A: SURFACE GAGE

REFERENCES: REF. #3, PP. 229-276
REF. #4, PP. 317-366
REF. #5, PP. 223-240, 285-290

TASK SHEET

IX-C-2b(TS)

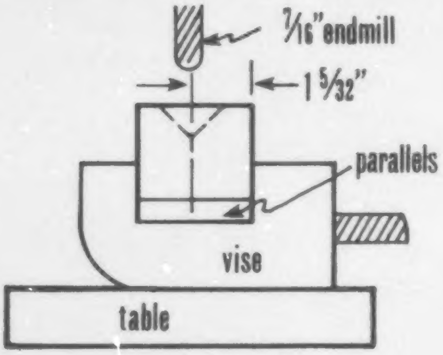
TASK: MILL VEE GROOVE WITH 7/32"^{R}

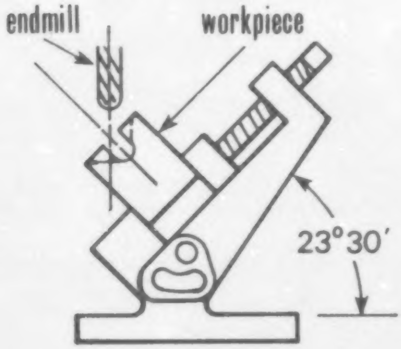
JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: VERTICAL MILLING MACHINE, UNIVERSAL VISE, 7/16" BALL-END END MILL, 7/16 END MILL HOLDER, 6" RULE, MILL FILE, DIAL INDICATOR, AND PART #17: BASE AS MACHINED IN PREVIOUS TASKS

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP 7/16" BALL-END END MILL	1. SELECT AND INSPECT 7/16" BALL-END MILL NOTE: END MILL WILL HAVE 7/32" SPHERICAL RADIUS 2. INSTALL END MILL INTO END MILL HOLDER NOTE: 7/16" END MILL HOLDER IS INSTALLED AS PER IX-C-2(TS) 3. CHECK END MILL FOR RUNNING TRUE
2. SET UP UNIVERSAL VISE	1. VISE IS MOUNTED ON MILL TABLE AS PER IX-C-2(TS), STEP #2 NOTE: VERTICAL ELEVATION POSITION OF VISE WILL BE ON ZERO DEGREES 2. ALIGN VISE NOTE: CHECK VISE JAW AND BOTTOM OF VISE FOR PROPER ALIGNMENT WITH DIAL INDICATOR
3. SET UP WORKPIECE  Fig. 1	1. CLEAN VISE AND PARALLELS 2. MOUNT WORKPIECE ON PARALLELS IN VISE NOTE: WORKPIECE WILL BE PLACED WITH LEFT END OF WORKPIECE ON PARALLELS WITH FRONT EDGE OF WORKPIECE TOWARD OPERATOR. REFER TO FIG. 1 3. TRUE WORKPIECE NOTE: INSPECT BOTH TOP SURFACE AND FRONT SURFACE FOR TRUE ALIGNMENT. USE DIAL INDICATOR

STEPS	KEY POINTS
4. MILL 7/32" RADII	1. CENTER END MILL ON CENTER LINE OF GROOVE NOTE: 1 5/32" FROM FRONT EDGE AS PER FIG. 1 2. RAISE TABLE UNTIL CONTACT IS MADE ON WORKPIECE BY END MILL 3. SET GRADUATED FEED COLLAR ON THE VERTICAL FEED AT ZERO 4. SET SPINDLE SPEED AND TABLE FEED NOTE: REFER TO REFERENCE CHART 5. MILL SLOT TO 13/16" DEPTH NOTE: SLOT WILL BE 7/16" WIDE WITH A 7/32"R RADIUS BOTTOM CENTERED 1 5/32" FROM FRONT EDGE 6. BURR EDGES
5. MILL SIDES OF VEE GROOVE  Fig. 2	1. CLEAR WORKPIECE FROM END MILL 2. SET VISE AT 23°30' ANGLE TO HORIZONTAL PLANE AS PER IX-C-2(TS), STEP #5. REFER TO FIG. 2 3. MILL SIDES OF GROOVE TO LAYOUT LINES NOTE: DO NOT CUT INTO 7/32" RADII. THE ANGLE CUTS SHOULD BLEND INTO THE RADIUS CUT NOTE: HOLD 1" WIDTH ON FACE OF ANGLE 21/32" FROM EDGE 4. BURR EDGES 5. REMOVE WORKPIECE FROM VISE 6. INSPECT WORKPIECE 7. REMOVE END MILL AND SECURE MACHINE

SKETCHES: DRAWING #3-A: SURFACE GAGE

REFERENCES: REF. #3, PP. 229-276
REF. #4, PP. 317-366
REF. #5, PP. 223-240, 285-290

TASK SHEET IX-C-2c(TS)

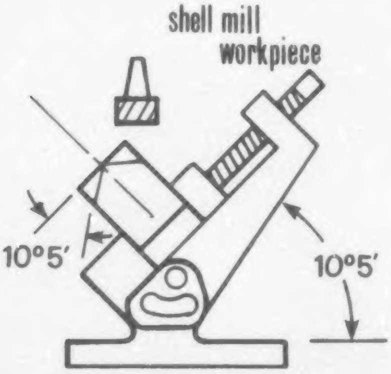
TASK: MACHINE 10°5' ANGLE ON TOP FACE

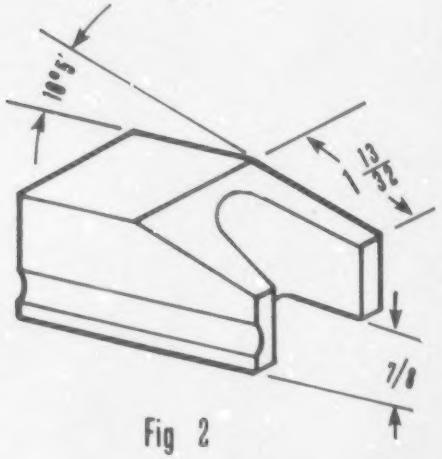
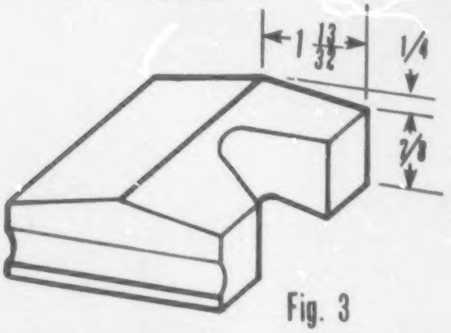
JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: VERTICAL MILLING MACHINE, UNIVERSAL VISE, 1 1/2" SHELL END MILL, SHELL MILL ARBOR, BEVEL PROTRACTOR, 6" RULE, MILL FILE, DIAL INDICATOR, AND PART #17: BASE AS PREVIOUSLY MACHINED
NOTE: 1 1/2" HEAVY DUTY END MILL MAY BE USED INSTEAD OF SHELL MILL

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP 1 1/2" SHELL END MILL	1. SELECT AND INSPECT 1 1/2" SHELL END MILL 2. INSTALL SHELL MILL ARBOR NOTE: INSTALLATION WILL BE THE SAME AS FOR END MILL HOLDER 3. INSTALL SHELL MILL ON ARBOR NOTE: INSPECT AND CLEAN ARBOR AND INSIDE OF SHELL MILL FOR BURRS, CHIPS, OR DIRT 4. CHECK SHELL MILL FOR RUNNING TRUE
2. SET UP UNIVERSAL	1. VISE IS MOUNTED ON MILL TABLE AS PER IX-C-2(TS), STEP #2 NOTE: POSITION SHOULD NOT HAVE BEEN CHANGED UPON COMPLETION OF TASK IX-C-2b(TS) 2. CHECK VISE JAWS FOR ALIGNMENT NOTE: VERTICAL ELEVATION POSITION OF VISE WILL BE ON ZERO DEGREES
3. SET UP WORKPIECE  Fig. 1	1. CLEAN VISE AND PARALLELS 2. MOUNT WORKPIECE ON PARALLELS IN VISE NOTE: TOP FACE OF WORKPIECE WILL BE FACE UP WITH THE FRONT EDGE FACING THE OPERATOR 3. TRUE WORKPIECE NOTE: CHECK TOP FACE AND FRONT EDGE WITH DIAL INDICATOR 4. CLEAR WORKPIECE FROM UNDER SHELL MILL

STEPS	KEY POINTS
	5. SET VISE ELEVATION AT 10°5' TO THE HORIZONTAL PLANE AS PER IX-C-2, STEP #5. REFER TO FIG. 1 NOTE: CHECK ANGLE WITH BEVEL PROTRACTOR
4. MACHINE FIRST 10°5' ANGLE  Fig 2	1. SET SPINDLE SPEED AND FEED 2. POSITION WORKPIECE UNDER HIGH POINT OF SHELL MILL 3. SET GRADUATED FEED COLLAR ON THE VERTICAL FEED AT ZERO 4. MILL FIRST SIDE NOTE: HOLD 7/8" FROM BOTTOM OF WORKPIECE NOTE: MACHINED SURFACE SHOULD BLEND WITH LAYOUT LINES. REFER TO FIG. 2 5. INSPECT WORKPIECE 6. REMOVE FROM VISE AND BURR NOTE: DO NOT CHANGE VISE SETTING 7. CHECK MACHINED SURFACE FOR ANGLE AND PERPENDICULARITY TO SIDES
5. MACHINE SECOND 10°5' ANGLE  Fig. 3	1. SET UP WORKPIECE AS PER PREVIOUS STEP NOTE: CHECK ALIGNMENT OF WORKPIECE 2. MACHINE SECOND ANGLE AS PER STEP #4 NOTE: HOLD DIMENSIONS AS PER FIG. 3 3. BURR EDGES 4. INSPECT WORKPIECE 5. HOLD WORKPIECE IN VISE AS SET UP FOR NEXT TASK

SKETCHES: DRAWING #3-A: SURFACE GAGE

REFERENCES: REF. #3, PP. 229-276
REF. #4, PP. 317-366
REF. #5, PP. 223-240, 285-290

TASK SHEET

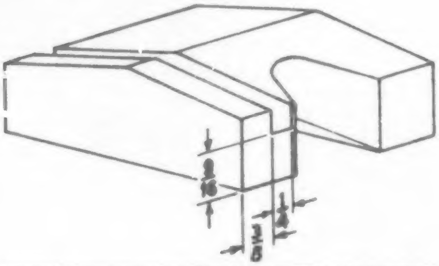
IX-C-2d(TS)

TASK: MILL 1/4" SLOT

JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: VERTICAL MILLING MACHINE, UNIVERSAL VISE, 1/4" END MILL, 1/4" END MILL HOLDER, 6" RULE, DEPTH MICROMETER, MILL FILE, DIAL INDICATOR AND PART #17: BASE AS MACHINED IN PREVIOUS TASKS

STEPS	KEY POINTS
1. SET UP 1/4" END MILL	1. REFER TO IX-C-2(TS) NOTE: INSPECT END MILL FOR CONDITION
2. SET UP UNIVERSAL VISE	1. REFER TO IX-C-2a(TS), STEP #2 NOTE: VERTICAL ELEVATION POSITION OF VISE WILL BE ON ZERO DEGREES 2. INSPECT VISE FOR TRUE ALIGNMENT
3. SET UP WORKPIECE	1. CLEAN VISE AND PARALLELS 2. MOUNT WORKPIECE ON PARALLELS IN VISE NOTE: MOUNT WORKPIECE WITH BOTTOM SURFACE ON PARALLELS WITH FRONT EDGE FACING OPERATOR. ANGULAR TOP FACE WILL BE UP 3. TRUE WORKPIECE NOTE: CHECK WITH DIAL INDICATOR TOP FACE FOR LEVEL POSITION AND FOR PARALLELISM TO END MILL
4. MILL 1/4" SLOT 	1. POSITION END MILL 3/8" FROM FRONT EDGE AS PER SKETCH. REFER TO FIG. 1 2. MILL SLOT TO DEPTH NOTE: HOLD 9/16" FROM BOTTOM OF WORKPIECE 3. BURR EDGES 4. INSPECT WORKPIECE 5. ROUTE TO SURFACE GRINDER

SKETCHES: DRAWING #3-A: SURFACE GAGE

REFERENCES: REF. #3, PP. 229-276
REF. #4, PP. 317-366
REF. #5, PP. 223-240, 285-290

JOB SHEET
ON
SURFACE GRINDER

JOB:	SURFACE GAGE	
MATERIALS:	PART #17: BASE AS MACHINED IN PREVIOUS TASKS	
TOOLS AND EQUIPMENT:	SURFACE GRINDER, GRINDING WHEEL, DIAMOND WHEEL DRESSER, MAGNETIC CHUCK, UNIVERSAL VISE, DIAL INDICATOR, 6" RULE, PARALLELS, AND MILL FILE	
GENERAL INSTRUCTIONS:	BEFORE BEGINNING THIS JOB READ REF. #3, PP. 287-297; REF. #4, PP. 407-454; REF. #5, PP. 325-352. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE	
PROCEDURES AND/OR TASKS:	X-B-1 (TS)	CHECK SURFACE GRINDER FOR PROPER OPERATING CONDITION
	*X-B-2 (TS)	SET UP, TRUE GRINDING WHEEL AND GRIND 10° 5' ANGLES
	X-B-1b (TS)	CLEAN AND SECURE SURFACE GRINDER HOLD FOR ASSEMBLY

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS.

1. PROPER OPERATION OF SURFACE GRINDER
2. CORRECT INSTALLATION AND SELECTION OF GRINDING WHEEL
3. GRINDING WHEEL DRESSED AND TRUED PROPERLY
4. PROPER SETUP OF TOOLING AND WORKPIECE
5. ALL DIMENSIONS HELD TO SPECIFICATIONS
6. OBSERVANCE OF ALL SAFE WORKING HABITS
7. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR MACHINE TOOLS, EQUIPMENT, SUPPLIES, AND STANDARDS

TASK SHEET X-B-2(TS)

TASK: SET UP, TRUE GRINDING WHEEL AND GRIND 10°5' ANGLES

JOB: SURFACE GAGE

TRADE: MACHINIST

TASK AND MATERIALS: SURFACE GRINDER, GRINDING WHEEL, DIAMOND WHEEL DRESSER, UNIVERSAL VISE, PARALLELS, 6" RULE, MAGNETIC CHUCK, MILL FILE, AND PART #17: BASE AS MACHINED IN PREVIOUS TASKS

TASK BREAKDOWN:

STEPS	KEY POINTS
1. INSPECT AND MOUNT GRINDING WHEEL	REFER TO X-B-1a(TS) STEP #1 CAUTION: DO NOT EXCEED RATED OPERATIONAL SPEED NOTE: CHECK FOR CHIPS OR CRACKS IN WHEEL
2. SET UP MAGNETIC CHUCK	REFER TO X-B-1a(TS) STEP #2
3. TRUE AND DRESS GRINDING WHEEL	REFER TO X-B-1a(TS) STEP #3
4. SET UP WORKPIECE	1. WIPE FACE OF MAGNETIC CHUCK CLEAN 2. WIPE BOTTOM OF UNIVERSAL BASE CLEAN NOTE: INSPECT FOR BURRS, NICKS, OR SHAVINGS THAT WOULD NOT PERMIT VISE TO SIT FLAT 3. MOUNT UNIVERSAL VISE ON MAGNETIC CHUCK NOTE: POSITION SO VISE IS PARALLEL TO GRINDING WHEEL NOTE: VISE HANDLE WILL BE DIRECTED AWAY FROM GRINDER COLUMN 4. TRUE VISE NOTE: CHECK VISE JAWS AND INSIDE BOTTOM OF VISE WITH DIAL INDICATOR CAUTION: DO NOT CUT MAGNETIC CHUCK ON WHILE USING DIAL INDICATOR 5. POSITION WORKPIECE ON PARALLELS IN VISE NOTE: TOP FACE TO BE SURFACE GROUND MUST CLEAR TOP OF VISE

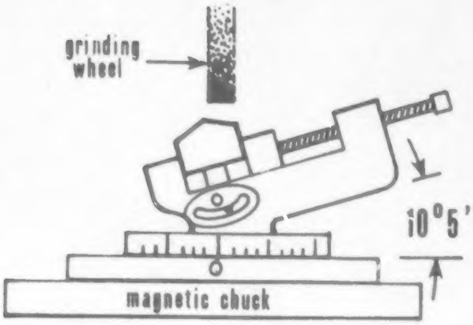


Fig. 1

STEPS	KEY POINTS
	NOTE: CLAMP WORKPIECE SO ENDS ARE AGAINST VISE JAWS. REFER TO FIGURE 1 6. ELEVATE VISE VERTICALLY TO 10° 5'. REFER TO IX-C-2(TS)
5. GRIND FIRST ANGLED SURFACE	1. REFER TO X-B-1a(TS) NOTE: LIMIT GRINDING TO .005" AND SPECIFIED TOLERANCE ON ANGLE 2. BURR EDGES
6. GRIND SECOND ANGLE	1. SET UP WORKPIECE AS IN STEP #4 NOTE: UNGROUND SURFACE WILL BE TOWARD MOVABLE JAW 2. POSITION GRINDING WHEEL OVER WORKPIECE 3. GRIND TO SPECIFIED SIZE NOTE: SAME AMOUNT AS IN STEP #5 NOTE: MAINTAIN SPECIFIED CENTER AND SIZE DIMENSIONS 4. BURR EDGES 5. REMOVE WORKPIECE
7. INSPECT WORKPIECE	1. INSPECT FOR SPECIFIED DIMENSIONS, FINISH, AND ANGLE 2. INSPECT HOLES, SLOTS, AND GROOVE FOR BURRS NOTE: TAPPED HOLES MAY REQUIRE RECHASING THREAD WITH A TAP HOLD FOR ASSEMBLY

SKETCHES: DRAWING #3-A: SURFACE GAGE

REFERENCES: REF. #3, PP. 287-297
REF. #4, PP. 407-454
REF. #5, PP. 325-352

JOB SHEET
ON
SURFACE GRINDER

JOB:	SURFACE GAGE
MATERIALS:	PART #24: ROCKER - 1/4" X 1 1/2" X 3" C.R. STEEL
TOOLS AND EQUIPMENT:	SURFACE GRINDER, GRINDING WHEEL, DIAMOND POINT WHEEL DRESSER, MAGNETIC CHUCK, 0-1" MICROMETER, AND MILL FILE
GENERAL INSTRUCTIONS:	BEFORE BEGINNING THIS JOB READ REF. #3, PP. 287-309; REF. #4, PP. 434-441; REF. #5, PP. 337-348. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE. NOTE: REMOVE ANY GREASE, OIL OR DIRT FROM WORKPIECE PRIOR TO GRINDING SURFACES

PROCEDURES AND/OR TASKS:	X-B-1(TS)	CHECK SURFACE GRINDER FOR PROPER OPERATING CONDITION
	X-B-1a(TS)	TRUE AND DRESS GRINDING WHEEL
	*X-B-3(TS)	GRIND WORKPIECE TO SPECIFIED THICKNESS NOTE: GRIND BOTH SIDES. HOLD .240" ± .005
	X-B-1b(TS)	CLEAN AND SECURE MACHINE ROUTE TO BENCH

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS.

1. CHECK CONDITION OF SURFACE GRINDER
2. CORRECT SELECTION AND INSPECTION OF GRINDING WHEEL
3. TRUE AND DRESS GRINDING WHEEL
4. ALL DIMENSIONS HELD TO SPECIFICATIONS AND TOLERANCE
5. OBSERVANCE OF SAFE WORKING HABITS
6. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS

TASK SHEET

X-B-3(TS)

TASK: GRIND WORKPIECE TO SPECIFIED THICKNESS

JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: SURFACE GRINDER, MAGNETIC CHUCK, GRINDING WHEEL, DIAMOND POINT WHEEL DRESSER, 0-1" MICROMETER MILL FILE, AND PART #24: ROCKER AS RECEIVED FROM THE SUPPLY ROOM

TASK BREAKDOWN:

STEPS	KEY POINTS
1. INSTALL GRINDING WHEEL	1. INSPECT FOR CRACKS OR CHIPS 2. SELECT CORRECT TYPE OF ABRASIVE 3. SELECT CORRECT RATED R.P.M. 4. CLEAN ARBOR 5. POSITION FELT WASHERS BETWEEN WHEEL AND STEEL WASHER 6. TIGHTEN NUT FIRMLY CAUTION: DO NOT TIGHTEN TOO TIGHT
2. INSTALL MAGNETIC CHUCK	1. WIPE TABLE CLEAN 2. WIPE BASE OF MAGNETIC CHUCK CLEAN 3. FASTEN TO TABLE NOTE: TIGHTEN T-BOLTS FIRMLY
3. TRUE AND DRESS GRINDING WHEEL	1. MOUNT DIAMOND WHEEL DRESSER ON MAGNETIC CHUCK 2. POSITION DIAMOND HOLDER AT 5° TO 15° FROM VERTICAL ANGLE 3. ROUGH DRESS WHEEL BY LOWERING GRINDING WHEEL ABOUT .001 TO .002" PER PASS NOTE: DRESS WHEEL UNTIL FACE OF WHEEL IS FLAT AND DRESSED AROUND COMPLETE CIRCUMFERENCE 4. FINISH DRESS WHEEL BY LOWERING GRINDING WHEEL .0005" AND TAKING SEVERAL PASSES ACROSS FACE OF WHEEL NOTE: INSPECT TO INSURE THAT WHEEL IS FLAT AND IS NOT LOADED WITH METAL FILINGS

STEPS	KEY POINTS
4. MOUNT WORKPIECE	1. WIPE WORKPIECE CLEAN OF DIRT AND OIL
	2. INSPECT FOR BURRS ON EDGES NOTE: WORKPIECE MUST LIE FLAT ON MAGNETIC CHUCK
	3. WIPE MAGNETIC CHUCK CLEAN AS IN PREVIOUS TASK
	4. CHUCK WORKPIECE ON MAGNETIC CHUCK NOTE: POSITION SO WORKPIECE MAKES CONTACT WITH AS MANY MAGNETIC INSERTS AS POSSIBLE
5. GRIND FIRST FACE	1. SET TABLE REVERSING DOGS, IF APPLICABLE NOTE: WHEEL SHOULD CLEAR EACH END BY 1"
	2. SET CROSSFEED, IF APPLICABLE NOTE: FOR ROUGH GRINDING .030" TO .050" FINISH GRINDING .005 TO .020
	3. LOWER WHEEL UNTIL LIGHT SPARK IS MADE NOTE: CHECK ADDITIONAL SPOTS ON WORKPIECE TO INSURE WHEEL IS SET ON HIGH SPOT
	4. START GRINDING OPERATION AS IN PREVIOUS TASK X-B-1a(TS) NOTE: USE COOLANT IF APPLICABLE
	5. GRIND FIRST FACE FOR CLEAN UP ONLY
	6. CUT OFF MACHINE
	7. REMOVE WORKPIECE AND BURR EDGES
6. GRIND SECOND FACE	1. WIPE WORKPIECE CLEAN
	2. WIPE MAGNETIC CHUCK CLEAN
	3. MOUNT WORKPIECE AND GRIND TO THICKNESS AS PER STEP #5 NOTE: HOLD .240" ± .005"
	4. REMOVE WORKPIECE AND BURR EDGES
	5. SECURE MACHINE
	ROUTE TO BENCH

SKETCH: DRAWING #3-A SURFACE GAGE

REFERENCES: REF. #3, PP. 287-309
REF. #4, PP. 434-441
REF. #5, PP. 337-348

JOB SHEET
ON
BENCH

IV-C-3(J)

JOB:	SURFACE GAGE	
MATERIALS:	PART #24: ROCKER AS SURFACE GROUND TO THICKNESS	
TOOLS AND EQUIPMENT:	LAYOUT DYE, COMBINATION SQUARE, 6" RULE, DIVIDER, SCRIBE, PRICK PUNCH, CENTER PUNCH, BALL PEEN HAMMER, SURFACE PLATE, 1/8" RADIUS GAGE, 1/4" RADIUS GAGE, 7/16"^{R} GAGE	
GENERAL INSTRUCTIONS:	BEFORE BEGINNING THIS JOB READ REF. #3, PP. 57-65; REF. #5, PP. 53-63. CHECK WITH INSTRUCTOR UPON COMPLETION OF LAYOUT PRIOR TO DRILLING HOLES.	
PROCEDURES AND/OR TASK:	IV-C-2(TS)	SET UP WORK BENCH AND LAYOUT TOOLS
	*IV-C-3(TS)	COMPLETELY LAYOUT ROCKER
		ROUTE TO DRILL PRESS

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS.

1. ALL LAYOUT LINES SCRIBED CLEAR AND DISTINCT
2. ALL CENTERS LOCATED AND CENTER PUNCHED ACCURATELY
3. ALL DIMENSIONS HELD TO SPECIFICATIONS AND TOLERANCE
4. OBSERVANCE OF SAFE WORKING HABITS
5. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT. AND STANDARDS

TASK SHEET IV-C-3(TS)

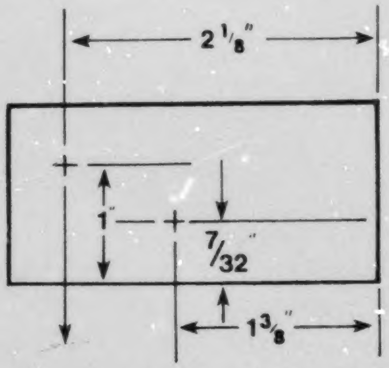
TASK: COMPLETELY LAYOUT ROCKER

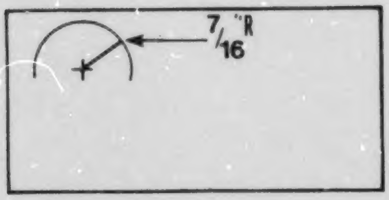
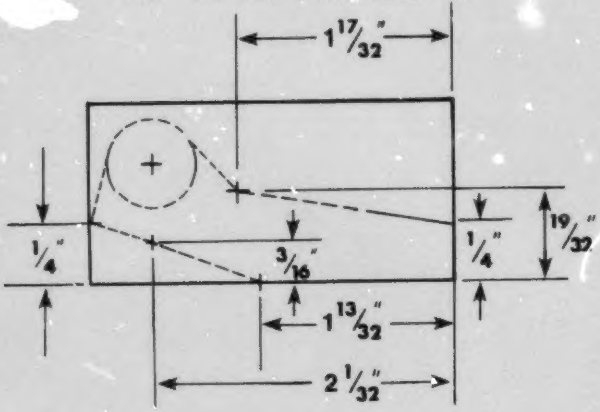
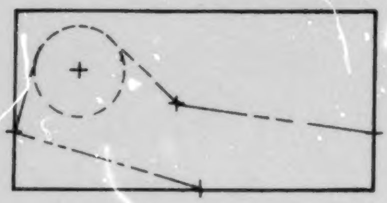
JOB: SURFACE GAGE

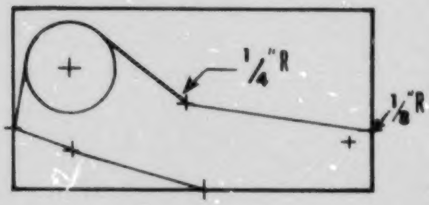
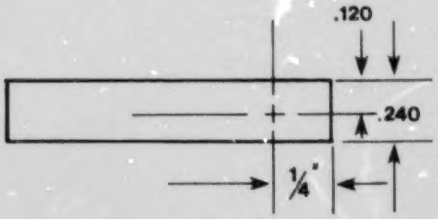
TRADE: MACHINIST

TOOLS AND EQUIPMENT: LAYOUT DYE, COMBINATION SQUARE, 6" RULE, DIVIDER, SCRIBE, PRICK PUNCH, CENTER PUNCH, BALL PEEN HAMMER, SURFACE PLATE, 1/8" RADIUS GAGE, 1/4" RADIUS GAGE, AND 7/16" RADIUS GAGE

TASK BREAKDOWN:

STEPS	KEY POINTS
1. INK WORKPIECE	1. INK ENTIRE WORKPIECE NOTE: WIPE WORKPIECE CLEAN AND DRY BEFORE INKING 2. ALLOW TO DRY
2. LAYOUT CENTERS FOR HOLES ON FACE  Fig. 1	1. POSITION WORKPIECE FACE UP ON SURFACE PLATE 2. WITH RIGHT EDGE OF WORKPIECE AS A REFERENCE, SCRIBE LINE PARALLEL TO EDGE 2 1/8" FROM EDGE 3. WITH SAME REFERENCE EDGE, SCRIBE LINE PARALLEL TO EDGE 1 3/8" FROM EDGE 4. WITH BOTTOM EDGE AS A REFERENCE, SCRIBE LINE PARALLEL TO EDGE 7/32" FROM EDGE AND INTERSECTING LINE IN KEY POINT #3 NOTE: THIS LOCATES THE CENTER FOR THE 1/8" HOLE 5. WITH SAME REFERENCE EDGE, SCRIBE LINE PARALLEL TO EDGE 1" FROM EDGE AND INTERSECTING LINE IN KEY POINT #2 NOTE: THIS LOCATES THE CENTER FOR THE 3/8" HOLE AND ALSO THE CENTER FOR THE 7/16" RADIUS NOTE: REFER TO FIGURE 1 FOR LAYOUT 6. LOCATE CENTER WITH PRICK PUNCH NOTE: RECHECK FOR ACCURACY

STEPS	KEY POINTS
2. LOCATE AND SCRIBE 7/16" RADII  Fig. 2	1. SET DIVIDER ON 7/16" RADII 2. WITH THE CENTER LOCATED IN KEY POINT #5 AS THE CENTER POINT, SCRIBE A 7/16"R ARC AS PER FIGURE 2
3. LAYOUT ANGLES  1 17/32" 19/32" 1/4" 3/16" 1/4" 1 13/32" 2 1/32" Fig. 3  Fig. 4	1. WITH RIGHT EDGE AS REFERENCE MEASURE 1 13/32" FROM EDGE NOTE: SCRIBE SHORT LINE NOTE: REFER TO FIGURE 3 FOR LAYOUT 2. WITH SAME REFERENCE EDGE SCRIBE SHORT LINE 2 1/32" FROM EDGE PARALLEL TO EDGE 3. WITH SAME EDGE AS REFERENCE EDGE SCRIBE LINE PARALLEL TO EDGE 1 17/32" FROM EDGE 4. WITH BOTTOM EDGE AS A REFERENCE EDGE SCRIBE TWO SHORT LINES 1/4" FROM BOTTOM EDGE NOTE: ONE WILL BE ON RIGHT END AND THE OTHER ON LEFT END 5. WITH BOTTOM EDGE AS REFERENCE EDGE SCRIBE LINE PARALLEL TO EDGE 3/16" FROM EDGE INTERSECTING LINE SCRIBED IN KEY POINT #2 6. WITH BOTTOM EDGE AS REFERENCE EDGE SCRIBE LINE PARALLEL TO EDGE 19/32" FROM EDGE INTERSECTING LINE SCRIBED IN KEY POINT #3 7. SCRIBE LINE FROM INTERSECTION POINT IN KEY POINT #6 TANGENT TO THE 7/16" RADII 8. SCRIBE LINE FROM THE 1/4" LAYOUT ON THE LEFT END OF WORKPIECE TANGENT TO THE 7/16" RADII NOTE: SEE FIGURE 4 FOR COMPLETE LAYOUT

STEPS	KEY POINTS
4. LAYOUT 1/4" RADIUS AND 1/8" RADIUS  Fig. 5	1. SELECT 1/4" RADIUS GAGE 2. PLACE RADIUS GAGE TANGENT TO THE TWO INTERSECTING LINES 3. SCRIBE RADIUS. REFER TO FIGURE 5 4. PLACE 1/8" RADIUS GAGE TANGENT TO THE TWO INTERSECTING LAYOUT LINES 5. SCRIBE 1/8" RADIUS. REFER TO FIGURE 5
5. LAYOUT #36 DRILLED HOLE  Fig. 6	1. SCRIBE LINE 1/4" FROM THE RIGHT EDGE OF WORKPIECE NOTE: MAKE LAYOUT ON THE BOTTOM SURFACE OF WORKPIECE 2. SCRIBE LINE PARALLEL TO THE FRONT SURFACE AND PERPENDICULAR TO THE LINE SCRIBED IN KEY POINT #1 NOTE: HOLD LINE .120" FROM FRONT AND BACK SURFACE. REFER TO FIGURE 6 NOTE: INTERSECTION OF THE TWO LINES WILL BE THE CENTER FOR THE HOLE 3. LOCATE HOLE WITH A PRICK PUNCH CAREFULLY
6. CHECK LAYOUT	1. RECHECK ALL DIMENSIONS FOR CORRECTNESS 2. CHECK ACCURACY IN LAYOUT 3. INSPECT LAYOUT FOR DISTINCT, CLEAR LINES ROUTE TO DRILL PRESS

SKETCH: DRAWING #3-B: SURFACE GAGE

REFERENCES:
REF. #3, PP. 57-65
REF. #4, PP. 51-61
REF. #5, PP. 53-63

VI-C-2(J)

JOB SHEET
ON
DRILL PRESS

JOB: SURFACE GAGE

MATERIALS: PART #24: ROCKER AS SURFACE GROUND TO THICKNESS COMPLETE WITH ALL LAYOUT OF LINES AND CENTERS

TOOLS AND EQUIPMENT: DRILL PRESS, DRILL PRESS VISE, PARALLELS, 1/8" DRILL, 3/8" DRILL, #36 DRILL, 3/4" DIAMETER 60° COUNTERSINK OR SPECIAL COUNTERBORE, AND 60° COUNTERSINK

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 95-115; REF. #4, PP. 185-210; REF. #5, PP. 117-135. CHECK WITH INSTRUCTOR PRIOR TO DRILLING HOLES AND UPON COMPLETION OF DRILLING OPERATION

NOTE: AT INSTRUCTOR'S DISCRETION, A #4 COMBINATION COUNTERSINK DRILL MAY BE USED TO DRILL AND COUNTERSINK THE 1/8" DRILLED HOLE

NOTE: AT INSTRUCTOR'S DISCRETION, THE 3/4" DIAMETER 60° COUNTERSINK MAY BE REPLACED BY A SPECIAL MADE TAPERED COUNTERBORE. A SPECIAL JOB AND TASK SHEET WILL BE WRITTEN FOR CONSTRUCTION OF THIS SPECIAL COUNTERBORE. IT IS RECOMMENDED THAT AS AN ADDITIONAL LEARNING EXPERIENCE, THE INSTRUCTOR USE THIS METHOD

PROCEDURE AND/OR TASK:	VI-A-1(TS)	CHECK DRILL FOR PROPER OPERATING CONDITIONS
	VI-A-1(TS)	SET UP DRILL VISE AND WORKPIECE
	*VI-C-2(TS)	DRILL ALL HOLES AND COUNTERSINK REQUIRED HOLES
TASK:	*VI-C-2a(TS)	COUNTERBORE HOLE WITH SPECIAL TAPERED COUNTERBORE
		SPECIAL JOB: GRIND SPECIAL TAPERED COUNTERBORE
	*VII-C-1(TS)	GRIND SPECIAL TAPERED COUNTERBORE NOTE: SEE ATTACHED JOB AND TASK SHEET ROUTE TO BAND SAW

CHECK POINTS: STUDENT TO CONFER WITH THE INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS.

1. PROPER OPERATION OF DRILL PRESS
2. CORRECT SELECTION AND INSPECTION OF DRILLS
3. CORRECT SETUP OF WORKPIECE
4. SPECIAL TAPERED COUNTERBORE PROPERLY GROUND
5. OBSERVANCE OF ALL SAFETY PROCEDURES
6. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS

TASK SHEET VI-C-2(TS)

TASK: DRILL ALL HOLES AND COUNTERSINK REQUIRED HOLES

JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: DRILL PRESS, DRILL PRESS VISE, PARALLELS, 1/8" DRILL, 3/8" DRILL, #36 DRILL, AND 3/4" DIAMETER 60° COUNTERSINK

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP WORKPIECE	1. PLACE IN VISE FRONT FACE UP NOTE: POSITION WORKPIECE ON PARALLELS
	2. SNUG VISE JAWS
	3. CHECK WORKPIECE FOR LEVEL POSITION
	4. TIGHTEN VISE FIRMLY
2. INSTALL 1/8" DRILL	1. SELECT CORRECT DRILL SIZE
	2. INSPECT CONDITION OF DRILL NOTE: REMOVE ANY BURRS ON DRILL SHANK
	3. CHUCK DRILL IN DRILL CHUCK
	4. TIGHTEN CHUCK
	5. CHECK DRILL FOR RUNNING TRUE
3. DRILL 1/8" HOLE NOTE: 2 - HOLES	1. SET SPINDLE SPEED
	2. POSITION WORKPIECE UNDER DRILL POINT NOTE: DRILL 1/8" PILOT FOR 3/8" DRILLED HOLE. CENTER IS SAME AS FOR 7/16" RADIUS
	3. DRILL 1/8" HOLE THROUGH
	4. RELOCATE WORKPIECE NOTE: LOCATE DRILL ABOVE CENTER FOR 1/8" DRILLED HOLE
	5. DRILL 1/8" HOLE THROUGH
	6. REMOVE 1/8" DRILL
4. INSTALL 3/8" DRILL	1. INSTALL DRILL AS IN PREVIOUS STEP #2
	2. CHECK FOR RUNNING TRUE
5. DRILL 3/8" HOLE	1. DRILL AS IN PREVIOUS STEP #3 NOTE: IF SPECIAL COUNTERBORE IS TO BE USED, STEPS #4 AND #5 ARE NOT NECESSARY
	2. REMOVE DRILL

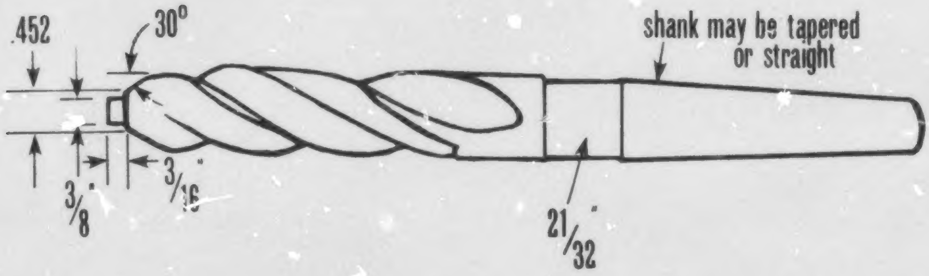
STEPS	KEY POINTS
6. INSTALL 3/4" COUNTERSINK	1. INSTALLATION IS THE SAME AS FOR DRILL 2. CHECK FOR RUNNING TRUE
7. COUNTERSINK 3/8" DRILLED HOLE	1. CHECK COUNTERSINK FOR CORRECT ALIGNMENT 2. SET SPINDLE SPEED 3. COUNTERSINK HOLE TO DEPTH NOTE: HOLD 21/32" ON HOLE OUTSIDE DIAMETER NOTE: HOLD .177" ON DEPTH OF COUNTERSINK NOTE: IF SPECIAL COUNTERBORE IS USED, DISREGARD STEPS #6 AND #7
8. COUNTERSINK 1/8" HOLE-FRONT SIDE	1. REPOSITION WORKPIECE NOTE: ALIGN COUNTERSINK WITH 1/8" DRILLED HOLE 2. COUNTERSINK HOLE TO DEPTH NOTE: HOLD 1/4" DIAMETER ON HOLE AS PER DRAWING #3-B 3. REMOVE WORKPIECE 4. BURR EDGES
9. COUNTERSINK 1/8" HOLE-BACK SIDE	1. POSITION WORKPIECE ON OPPOSITE SIDE 2. FASTEN WORKPIECE IN VISE AS IN PREVIOUS STEPS 3. COUNTERSINK 1/8" HOLE AS IN PREVIOUS STEP #8 NOTE: HOLD 1/4" DIAMETER ON HOLE AS PER DRAWING #3-B 4. REMOVE WORKPIECE 5. INSPECT ALL HOLES DRILLED AND COUNTERSUNK 6. BURR EDGES
10. DRILL #36 HOLE	1. INSTALL #36 DRILL AS PER STEP #2 2. SET UP WORKPIECE WITH BOTTOM FACE UP NOTE: HOLE WILL BE DRILLED FROM BOTTOM 3. LOCATE CENTER OF HOLE WITH DRILL 4. DRILL HOLE NOTE: HOLE 3/8" DEEP 5. REMOVE DRILL 6. INSPECT WORKPIECE 7. BURR EDGES 8. SECURE DRILL PRESS

SKETCH: DRAWING #3-B, SURFACE GAGE

REFERENCES: REF. #3, PP. 95-115
REF. #4, PP. 185-210
REF. #5, PP. 117-135

JOB SHEET
ON
ENGINE LATHE

JOB: SURFACE GAGE



MATERIALS: 1 - 21/32" H.S.S. DRILL OR LARGER
NOTE: SHANK MAY BE TAPERED OR STRAIGHT

TOOLS AND EQUIPMENT: ENGINE LATHE, TOOL POST GRINDER, 0-1" MICROMETER, BEVEL PROTRACTOR, AND 6" RULE
NOTE: CYLINDRICAL GRINDER OR TOOL AND CUTTER GRINDER MAY BE USED

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 196-198; REF. #4, PP. 283-284; REF. #5, PP. 189-190. CHECK WITH INSTRUCTOR PRIOR TO GRINDING SPECIAL TAPERED COUNTERBORE, AND UPON COMPLETION OF GRINDING OPERATION.

PROCEDURE AND/OR TASK:

VII-A-1(TS)	CHECK ENGINE LATHE FOR PROPER OPERATING CONDITION
*VII-C-1(TS)	GRIND SPECIAL TAPERED COUNTERBORE

CHECK POINTS: STUDENT TO CONFER WITH THE INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS.

1. PROPER OPERATION OF ENGINE LATHE
2. PROPER SETUP OF TOOL POST GRINDER
3. CORRECT SETUP OF WORKPIECE
4. OBSERVANCE OF ALL SAFETY PROCEDURES
5. CORRECT ANGLE AND DIAMETER OF COUNTERBORE
6. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS

TASK SHEET VII-C-1(TS)

TASK: GRIND SPECIAL TAPERED COUNTERBORE

JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: ENGINE LATHE, TOOL POST GRINDER, 0-1" MICROMETER, BEVEL PROTRACTOR, 6" RULE, AND DIAMOND WHEEL DRESSER

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP TOOL POST GRINDER	1. MOUNT TOOL POST GRINDER ON COMPOUND REST 2. ADJUST GRINDER SPINDLE TO CENTER HEIGHT OF LATHE 3. MOUNT PROPER GRINDING WHEEL ON GRINDER 4. TRUE AND DRESS GRINDING WHEEL NOTE: COVER LATHE WAYS WITH CANVAS OR CLOTH TO PROTECT AGAINST GRINDING DUST NOTE: PLACE SMALL PAN OF WATER DIRECTLY UNDER GRINDING WHEEL TO CATCH GRINDING DUST
2. SET UP DRILL	1. CHUCK IN LATHE SPINDLE NOTE: USE 3-JAW CHUCK FOR STRAIGHT SHANK DRILL. SPINDLE SLEEVES MAY BE USED FOR TAPER SHANK DRILL 2. CHECK TO INSURE DRILL IS RUNNING TRUE 3. SET SPINDLE SPEED AT SLOW R.P.M. NOTE: LATHE SPINDLE DIRECTION IS REVERSED
3. GRIND 3/8" DIAMETER	1. SET GRINDING WHEEL FACE PARALLEL TO DRILL CENTER AXIS 2. GRIND 3/8" DRILL TO SIZE NOTE: FEED GRINDING WHEEL IN SLOWLY NOTE: HOLD .375" DIAMETER 3/16" LONG CAUTION: DO NOT BURN DRILL

STEPS	KEY POINTS
4. GRIND 30° TAPER	1. SET COMPOUND REST AT 30° ANGLE NOTE: 30° MEASURED FROM CENTER AXIS OF LATHE 2. SET SPINDLE SPEED AT SLOW R.P.M. NOTE: SPINDLE DIRECTION IS REVERSED 3. GRIND 30° ANGLE CAUTION: DO NOT BURN DRILL NOTE: HOLD .452" ON SMALL END OF TAPER AND .656" ON LARGE END NOTE: LENGTH OF TAPER SHOULD BE ABOUT .177"
5. INSPECT	1. CHECK 3/8" DIAMETER 3/16" LONG 2. CHECK 30° TAPER NOTE: 60° INCLUDED ANGLE 3. CHECK SMALL DIAMETER FOR .452" 4. CHECK LENGTH OF TAPER FOR .177" APPROXIMATELY 11/64" 5. HONE WITH SLIP STONE 6. SECURE ENGINE LATHE NOTE: CLEAN GRINDING DUST OFF LATHE AND LUBRICATE WAYS

SKETCH: DRAWING WITH DRILL SPECIFICATIONS AS ATTACHED TO JOB SHEET

REFERENCES:
REF. #3, PP. 196-198
REF. #4, PP. 283-284
REF. #5, PP. 189-190

TASK SHEET VI-C-2a(TS)

TASK: COUNTERBORE 3/8" HOLE WITH SPECIAL TAPERED COUNTERBORE

JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: DRILL PRESS, DRILL PRESS VISE, SPECIAL COUNTERBORE, 6" RULE, VERNIER CALIPER AND PART #24: ROCKER AS MACHINED IN PREVIOUS TASK

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP WORKPIECE	1. POSITION WORKPIECE IN VISE WITH FRONT FACE UP AS PER VI-C-2(TS) STEP #2 NOTE: POSITION WORKPIECE ON PARALLELS 2. FASTEN SECURELY IN VISE NOTE: COUNTERBORE PREVIOUSLY MADE IN SPECIAL TASK VII-C-1(TS)
2. INSTALL SPECIAL TAPERED COUNTERBORE	1. INSTALL COUNTERBORE IN DRILL SPINDLE NOTE: DRILL SHANK MAY BE TAPERED OR STRAIGHT. INSTALL AS IN PREVIOUS TASKS ON DRILL INSTALLATION 2. CHECK FOR RUNNING TRUE
3. COUNTERBORE 3/8" HOLE	1. SET SPINDLE SPEED 2. COUNTERBORE TAPERED HOLE NOTE: HOLD 21/32" DIAMETER ON THE OUTSIDE FACE AND 1/16" FLAT FROM BOTTOM. REFER TO DRAWING #3-B, SURFACE GAGE 3. INSPECT WORKPIECE 4. BURR EDGES 5. SECURE DRILL PRESS ROUTE TO BAND SAW

SKETCH: DRAWING #3-B, SURFACE GAGE

REFERENCES: REF. #3, PP. 95-115
REF. #4, PP. 185-210
REF. #5, PP. 117-135

V-B-1(J)

JOB SHEET
ON
BAND SAW

JOB: SURFACE GAGE

MATERIALS: PART #24: ROCKER AS MACHINED IN PREVIOUS TASKS

TOOLS AND EQUIPMENT: VERTICAL BAND SAW, 10 PITCH METAL CUTTING BAND SAW BLADE, AND MILL FILE

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 127-133; REF. #4, PP. 313-325; REF. #5, PP. 99-114. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE.

PROCEDURE AND/OR TASK:

	V-A-1(TS)	CHECK BAND SAW FOR PROPER OPERATING CONDITION
	*V-B-1(TS)	BAND SAW ROCKER
	V-A-1a(TS)	CLEAN BAND SAW

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASK.

1. CHECK BAND SAW FOR OPERATING CONDITION
2. INSPECT BAND SAW BLADE FOR CONDITION, CORRECT TOOTH PITCH, AND WIDTH OF BLADE
3. HOLD ALL CUTS TO 1/64" OF LAYOUT LINES
   NOTE: DO NOT CUT INTO LAYOUT LINES
4. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS
5. OBSERVANCE OF ALL SAFETY PROCEDURES

TASK SHEET

V-B-1(TS)

TASK: BAND SAW ROCKER

JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: VERTICAL BAND SAW, 10 PITCH METAL CUTTING BAND SAW BLADE, MILL FILE, AND PART #24: ROCKER AS LAYOUT LINES ARE MADE AND MACHINED IN PREVIOUS TASK

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP BAND SAW	1. INSPECT BLADE FOR CONDITION, CORRECT BLADE PITCH, AND WIDTH OF BLADE NOTE: 10 TO 14 PITCH BLADE SHOULD BE USED NOTE: CONSULT JOB SELECTOR CHART
	2. CHECK WORK TABLE FOR HORIZONTAL POSITION NOTE: TABLE SURFACE MUST BE SQUARE WITH BAND SAW BLADE NOTE: CHECK WITH SQUARE OR BY MAKING A TRIAL CUT AND CHECKING
	3. SET CUTTING SPEED NOTE: CONSULT JOB SELECTOR CHART
	4. LOWER SAW GUIDE POST AND CLAMP NOTE: APPROXIMATELY 3/8" TO 1/2" ABOVE WORKPIECE
	5. CUT MACHINE ON NOTE: CHECK TRACKING OF BLADE
	6. CUT COOLANT PUMP VALVE ON
2. SAW STRAIGHT LAYOUT LINES	1. BRING WORKPIECE IN CONTACT WITH BLADE SLOWLY CAUTION: SAFETY GLASSES MUST BE WORN
	2. EXERT LIGHT STEADY PRESSURE ON WORKPIECE NOTE: PRESSURE IS APPLIED DIRECTLY INTO TEETH OF BLADE CAUTION: DO NOT TWIST WORKPIECE OR APPLY PRESSURE FROM THE SIDE
	3. CUT STRAIGHT LINES FIRST

STEPS	KEY POINTS
	NOTE: CUT ON OUTSIDE OF LAYOUT LINE. HOLD APPROXIMATELY 1/64" FROM LAYOUT LINE
4. CUT RADII LINES	1. USE VERY LIGHT FORWARD FEED CAUTION: DO NOT TWIST BLADE
	2. REVOLVE WORKPIECE SLOWLY LETTING THE BLADE CUT FREELY CAUTION: DO NOT APPLY HEAVY PRESSURE NOTE: MAINTAIN STEADY REVOLVING OF WORKPIECE CAUTION: DO NOT PERMIT HANDS OR FINGERS TO BE PLACED IN FRONT OF BLADE AT ANY TIME
	3. CUT OFF MACHINE CAUTION: DO NOT REMOVE WORKPIECE OR ANY SMALL WASTE PIECES UNTIL MACHINE IS CUT OFF
	4. REMOVE WORKPIECE AND INSPECT
	5. REMOVE ALL BURRS WITH A FILE CAUTION: AVOID CONTACT WITH SHARP BURRS
5. SECURE MACHINE	1. REMOVE ALL SCRAP MATERIAL
	2. BRUSH TABLE OFF
	3. WIPE TABLE WITH CLEAN RAG
	4. CUT COOLANT VALVE OFF
	ROUTE TO BENCH

SKETCHES: DRAWING #3-B: SURFACE GAGE

REFERENCES: REF. #3, PP. 127-133
REF. #4, PP. 313-325
REF. #5, PP. 99-114

JOB SHEET
ON
BENCH

JOB: SURFACE GAGE

MATERIALS: PART #24: ROCKER AS MACHINED IN PREVIOUS TASKS

TOOLS AND EQUIPMENT: BENCH VISE, VISE CAPS, MILL FILE, HALF ROUND FILE, TAP WRENCH, #6-32 N.C. TAPER TAP, AND #3-32 N.C. BOTTOM TAP

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 67-68, 75-78, 84-90; REF. #4, PP. 121-122; REF. #5, PP. 68-74. CHECK WITH INSTRUCTOR UPON COMPLETION OF TASKS.

PROCEDURE AND/OR TASKS:

IV-C-4(TS)	FILE WORKPIECE TO FINISH SIZE
IV-C-4a (TS)	TAP #6-32 N.C. HOLE
	HOLD FOR ASSEMBLY

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASK.

1. WORKPIECE CAREFULLY CLAMPED IN VISE PROTECTED BY VISE CAPS
2. REMOVAL OF ALL SAW MARKS ON WORKPIECE EDGES
3. EDGE SURFACES SQUARE WITH FACE SURFACE
4. ALL RADII SMOOTH AND TANGENT TO STRAIGHT EDGES
5. ALL DIMENSIONS HELD TO SPECIFICATIONS
6. OBSERVANCE OF ALL SAFETY PROCEDURES
7. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS

JOB SHEET
ON
HORIZONTAL MILLING MACHINE

IX-C-3(J)

JOB:	SURFACE GAGE	
MATERIALS:	PART #5: 7/16" X 7/16" X 1" COLD ROLL SQUARE	
TOOLS AND EQUIPMENT:	HORIZONTAL MILLING MACHINE, MILL VISE, ARBOR AND SPACING COLLARS, 7/16" CONCAVE MILLING CUTTER, 1/32" SLITTING SAW, PARALLELS, 6" RULE, DIAL INDICATOR, COMBINATION SQUARE, AND 7/32" RADIUS GAGE	
GENERAL INSTRUCTIONS:	BEFORE BEGINNING THIS JOB READ REF. #3, PP. 229-270; REF. #4, PP. 317-354; REF. #5, PP. 223-241. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE.	
PROCEDURES AND/OR TASKS:	IX-A-1(TS)	CHECK HORIZONTAL MILL FOR PROPER OPERATING CONDITIONS
	IX-A-1a(TS)	SET UP MILLING MACHINE ARBOR AND CUTTER
	*IX-C-3(TS)	MILL 7/32" RADIUS ON TWO ENDS ROUTE TO BENCH AND DRILL PRESS
	*IX-C-3a(TS)	MILL 1/32" SLOT HOLD FOR ASSEMBLY

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS.

1. CHECK MILLING MACHINE FOR PROPER OPERATING CONDITION
2. SELECTION AND INSPECTION OF MILLING CUTTERS
3. CORRECT SETUP OF TOOLING AND WORKPIECE
4. ALL DIMENSIONS AND FINISH HELD TO SPECIFICATIONS
5. OBSERVANCE OF ALL SAFETY PROCEDURES
6. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS

TASK SHEET

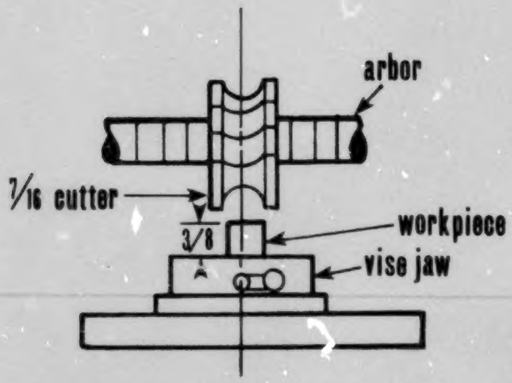
TASK: MILL 7/32" RADIUS ON TWO ENDS

JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: HORIZONTAL MILLING MACHINE, MILL VISE, ARBOR AND SPACING COLLARS, 7/16" CONCAVE MILLING CUTTER, 6" RULE, MILL FILE, PARALLELS, DIAL INDICATOR, 7/32" RADIUS GAGE, AND PART #5: CLAMP 7/16" X 7/16" X 1" C.R.

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP MILLING MACHINE	1. SET UP ARBOR AND SPACING COLLARS 2. MOUNT 7/16" CONCAVE CUTTER NOTE: SET CUTTER ACCORDING TO DIRECTION OF FEED. DO NOT CLIMB MILL 3. SET MACHINE FEED AND SPINDLE SPEED
2. SET UP WORKPIECE  Fig. 1	1. MOUNT VISE ON MILL TABLE NOTE: JAWS OF VISE WILL BE PARALLEL TO ARBOR AND PERPENDICULAR TO CUTTER NOTE: CHECK VISE ALIGNMENT WITH DIAL INDICATOR 2. MOUNT WORKPIECE IN VISE NOTE: WORKPIECE WILL BE POSITIONED ON END ABOUT 3/8" ABOVE VISE JAWS. REFER TO FIGURE 1. NOTE: USE PARALLEL TO ELEVATE WORKPIECE 3. SNUG VISE JAWS 4. CHECK WORKPIECE ALIGNMENT NOTE: CHECK VERTICAL AND HORIZONTAL ALIGNMENT WITH DIAL INDICATOR 5. TIGHTEN VISE

STEPS	KEY POINTS
3. MACHINE FIRST END	1. CENTER WORKPIECE WITH CUTTER. REFER TO FIGURE 1 2. MACHINE END OF WORKPIECE TO MINIMUM CLEANUP NOTE: RADII CUT SHOULD BLEND INTO THE SIDES OF THE WORKPIECE 3. REMOVE WORKPIECE AND BURR EDGE
4. MACHINE SECOND END	1. WIPE VISE JAWS AND PARALLEL CLEAN 2. SET UP WORKPIECE AS PER STEP #2 NOTE: RADIUS END IS PLACED ON PARALLEL BAR AND IS PARALLEL TO VISE JAWS 3. ALIGN WORKPIECE WITH DIAL INDICATOR 4. TIGHTEN VISE 5. MACHINE RADIUS AS PER STEP #3 NOTE: HOLD 15/16" LENGTH NOTE: RADIUS ENDS ARE 90° REMOVED. SEE FIGURE 2 6. REMOVE WORKPIECE AND BURR ALL EDGES NOTE: DO NOT TAKE SETUP ON MILL DOWN AS IT WILL BE USED AFTER LAYING OUT CENTERS AND DRILLING HOLES ROUTE TO BENCH

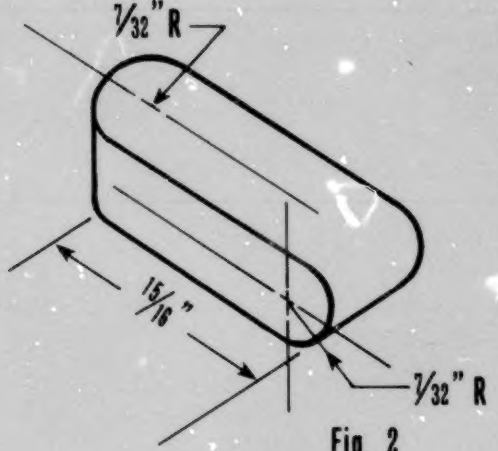


Fig. 2

SKETCHES: DRAWING #3-B: SURFACE GAGE

REFERENCES: REF. #3, PP. 229-270
REF. #4, PP. 317-354
REF. #5, PP. 223-241

IV-C-5(J)

JOB SHEET
ON
BENCH

JOB: SURFACE GAUGE

MATERIALS: PART #5: CLAMP AS MACHINED IN PREVIOUS TASK

TOOLS AND EQUIPMENT: LAYOUT INK, COMBINATION SQUARE, SCRIBE, PRICK PUNCH, CENTER PUNCH, BALL PEEN HAMMER, AND DIVIDER

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB, READ REF. #3, PP. 57-65; REF. #4, PP. 51-61; REF. #5, PP. 53-63. CHECK WITH INSTRUCTOR UPON COMPLETION OF LAYOUT WORK.

PROCEDURES AND/OR TASKS:	IV-C-5 (TS)	INK LAYOUT SURFACES
	*IV-C-5a (TS)	LAYOUT CENTERS FOR DRILLED HOLES
		ROUTE TO DRILL PRESS

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS.

1. ACCURACY OF CENTER LOCATIONS IN MAKING LAYOUT
2. CENTERS LOCATED WITH PRICK PUNCH ACCURATELY
3. CENTERS LOCATED WITH CENTER PUNCH ACCURATELY

TASK SHEET IV-C-5a(TS)

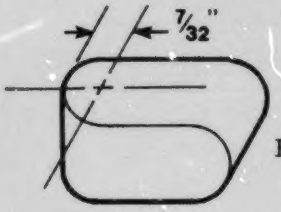
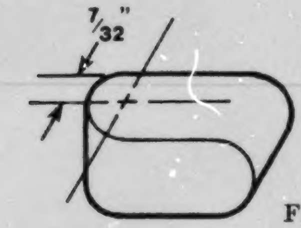
TASK: LAYOUT CENTERS FOR DRILLED HOLES

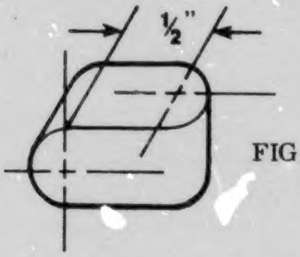
JOB: SURFACE GAUGE

TRADE: MACHINIST

TOOLS AND MATERIALS: LAYOUT INK, COMBINATION SQUARE, SCRIBE, PRICK PUNCH, CENTER PUNCH, BALL PEEN HAMMER, DIVIDER, AND PART #5 AS MACHINED IN PREVIOUS TASKS

TASK BREAKDOWN:

STEPS	KEY POINTS
1. INK WORKPIECE	1. WIPE WORKPIECE FREE OF OIL AND DIRT 2. APPLY LIGHT COAT OF INK ON TWO ADJACENT SIDES 3. ALLOW TO DRY PROPERLY
2. LAYOUT FIRST CENTER 7/32" FROM END  FIG. 1	1. SET COMBINATION SET ON 7/32" 2. PLACE SQUARE HEAD OF COMBINATION SET AGAINST ONE END OF WORKPIECE NOTE: 6" RULE CAN BE USED NOTE: KEEP BLADE OF COMBINATION SET PARALLEL TO EDGE OF WORKPIECE 3. SCRIBE LINE ACROSS FACE OF WORKPIECE 7/32" FROM END. REFER TO FIG. 1
3. LAYOUT CENTER 7/32" FROM EDGE  FIG. 2	1. HOLD SETTING ON 7/32" 2. PLACE SQUARE AGAINST SIDE OF WORKPIECE 3. SCRIBE LINE PARALLEL TO EDGE OF WORKPIECE AND PERPENDICULAR TO PREVIOUS SCRIBE LINE. REFER TO FIG. 2 NOTE: INTERSECTION OF TWO LINES WILL BE CENTER 4. CHECK ACCURACY OF LAYOUT
4. LOCATE CENTER	1. PLACE POINT OF PRICK PUNCH ON CENTER OF LAYOUT 2. CAREFULLY STRIKE PUNCH WITH HAMMER 3. CHECK LOCATION OF INDENTION

STEPS	KEY POINTS
	NOTE: CORRECT IF NECESSARY
	4. CENTER PUNCH CENTER CAREFULLY
5. LAYOUT SECOND CENTER	1. TURN WORKPIECE OVER 90 DEGREES NOTE: FACE ADJACENT TO PREVIOUS LAYOUT WILL BE FACE UP
 FIG. 3	2. LAYOUT SECOND CENTER AS PER FIRST CENTER IN STEPS 2-4 NOTE: HOLD CENTER OF LAYOUT 1/2" FROM PREVIOUS CENTER AS PER DRAWING. REFER TO FIG. 3 NOTE: LAYOUT WILL BE ON OPPOSITE END FROM PREVIOUS LAYOUT
	3. INSPECT LAYOUT FOR ACCURACY 4. ROUTE TO DRILL PRESS

SKETCHES: DRAWING NO. 3-B; PART #5, CLAMP, SURFACE GAUGE

JOB SHEET
ON
DRILL PRESS

VI-C-3(J)

JOB:	SURFACE GAGE	
MATERIALS:	PART #5: CLAMP AS MACHINED IN PREVIOUS TASK, WITH DRILLED HOLE CENTERS AND THE 1/32" SLOT LAID OUT	
TOOLS AND EQUIPMENT:	DRILL PRESS, DRILL PRESS VISE, JACOB CHUCK AND KEY, 1/4" DRILL, .265" (17/64") REAMER, 19/64" DRILL, .312" (5/16") REAMER, 60° COUNTERSINK, AND VERNIER CALIPER	
GENERAL INSTRUCTIONS:	BEFORE BEGINNING THE JOB READ REF. #3, PP. 95-118; REF. #4, PP. 177-210; REF. #5, PP. 115-134. CHECK WITH INSTRUCTOR BEFORE OPERATING DRILL PRESS AND UPON COMPLETION OF DRILL PRESS	
PROCEDURES AND/OR TASK:	VI-A-1(TS)	CHECK DRILL PRESS FOR PROPER OPERATING CONDITION
	VI-A-1a(TS)	SET UP DRILL PRESS VISE AND WORKPIECE
	*VI-C-3(TS)	DRILL, REAM, AND COUNTERSINK HOLES ROUTE TO HORIZONTAL MILL
CHECK POINTS:	STUDENTS TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS.	

1. CHECK DRILL PRESS FOR PROPER OPERATING CONDITION
2. CORRECT SELECTION AND PROPER INSPECTION OF DRILLS, REAMER, AND COUNTERSINK
3. CORRECT SETUP OF WORKPIECE
4. ALL DIMENSIONS HELD TO SPECIFICATIONS
5. OBSERVANCE OF ALL SAFETY PROCEDURES
6. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS

TASK SHEET VI-C-3(TS)

TASK: DRILL, REAM, AND COUNTERSINK HOLES

JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: DRILL PRESS, DRILL PRESS VISE, CHUCK AND KEY, 1/4" DRILL, 17/64" REAMER, 60° COUNTERSINK, 19/64" DRILL, 5/16" REAMER, MILL FILE, AND VERNIER CALIPER

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP VISE	1. WIPE OFF DRILL TABLE 2. FASTEN VISE TO TABLE NOTE: WORKPIECE CANNOT BE ALLOWED TO MOVE IN ORDER TO DRILL AND REAM ACCURATELY
2. INSTALL 1/4" DRILL	1. INSPECT AND SELECT CORRECT DRILL 2. INSTALL IN CHUCK 3. CHECK FOR RUNNING TRUE
3. SET UP WORKPIECE	1. MOUNT WORKPIECE IN VISE NOTE: THE HOLE CENTER ON THE END WITH THE SLOT WILL BE POSITIONED UPRIGHT 2. LOCATE DRILL POINT WITH CENTER 3. TIGHTEN VISE 4. CHECK FOR ALIGNMENT
4. DRILL 1/4" HOLE	1. SET SPINDLE SPEED AND FEED 2. DRILL HOLE THROUGH CAUTION: DO NOT DRILL INTO DRILL VISE BASE NOTE: LUBRICATE DRILL 3. CUT OFF MACHINE 4. REMOVE DRILL BIT NOTE: DO NOT REMOVE WORKPIECE 5. INSPECT HOLE
5. REAM HOLE TO .265"	1. SELECT AND INSPECT REAMER NOTE: CHECK REAMER FOR EXACT SIZE 2. INSTALL REAMER AS PER DRILL BIT NOTE: CHECK FOR RUNNING TRUE 3. ALIGN REAMER WITH HOLE

STEPS	KEY POINTS
	NOTE: UNLESS TABLE OR WORKPIECE HAS BEEN MOVED, THE HOLE AND REAMER SHOULD BE ALIGNED
	4. SET SPINDLE SPEED AND FEED NOTE: APPROXIMATELY 1/2 TO 2/3 THAT USED FOR DRILLING. FEED ABOUT 2 TO 3 TIMES THAT FOR DRILLING
	5. REAM HOLE THROUGH NOTE: APPLY COOLANT FREELY
	6. CUT OFF MACHINE AND INSPECT HOLE NOTE: DO NOT MOVE WORKPIECE
6. COUNTERSINK .265" REAMED HOLE	1. SELECT AND INSPECT 60° COUNTERSINK
	2. INSTALL AS PER PREVIOUS STEPS FOR DRILL AND REAMER
	3. ALIGN COUNTERSINK WITH HOLE
	4. COUNTERSINK HOLE. HOLD 1/16" DEEP
	5. CUT OFF MACHINE
	6. INSPECT WORKPIECE
	7. REMOVE WORKPIECE AND BURR
7. DRILL 19/64" HOLE	1. INSTALL 19/64" DRILL AS PER PREVIOUS TASKS
	2. SET UP WORKPIECE AS PER STEP #3 NOTE: CENTER FOR 19/64" HOLE WILL BE FACE UP LOCATED UNDER 19/64" DRILL
	3. SET SPINDLE SPEED AND FEED
	4. DRILL 19/64" HOLE THROUGH
	5. CUT OFF MACHINE AND INSPECT HOLE
	6. REMOVE DRILL BIT
8. REAM HOLE .312"	1. INSTALL .312" (5/16") REAMER
	2. ALIGN REAMER AND HOLE
	3. SET SPINDLE SPEED AND FEED AS PER STEP #5
	4. REAM TO SIZE NOTE: APPLY COOLANT FREELY
	5. CUT OFF MACHINE AND REMOVE WORKPIECE
	6. INSPECT AND BURR WORKPIECE
	7. SECURE DRILL PRESS ROUTE TO MILLING MACHINE

STEPS	KEY POINTS

SKETCHES: DRAWING #3-B: SURFACE GAGE

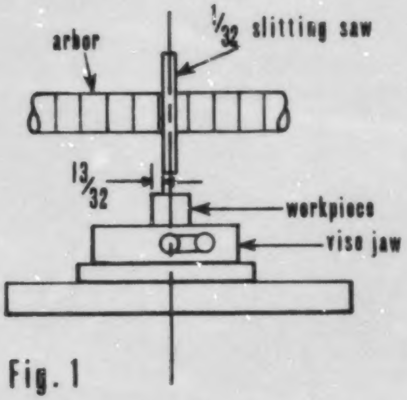
REFERENCES: REF. #3, PP. 95-118
REF. #4, PP. 177-210
REF. #5, PP. 115-134

TASK SHEET

IX-C-3a(TS)

TASK:	MILL 1/32" SLOT
JOB:	SURFACE GAGE
TRADE:	MACHINIST
TOOLS AND MATERIALS:	HORIZONTAL MILL, MILL VISE, ARBOR AND SPACING COLLARS, 1/32" SLITTING SAW, 6" RULE, MILL FILE, COMBINATION SQUARE, DIAL INDICATOR, PART #5: CLAMP AS MACHINED IN PREVIOUS TASKS

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP MILLING MACHINE	1. SET UP ARBOR AND SPACING COLLARS AS PER IX-C-3(TS) 2. MOUNT 1/32" SLITTING SAW 3. SET TABLE FEED AND SPINDLE SPEED NOTE: DO NOT CLIMB MILL
2. MOUNT WORKPIECE  Fig. 1	1. MILL VISE IS POSITIONED AND SET UP AS PER IX-C-3(TS) NOTE: CHECKING ALIGNMENT OF VISE IS NOT REQUIRED IF SETUP HAS NOT BEEN TAKEN DOWN 2. PLACE WORKPIECE IN VISE NOTE: END WITH REAMED AND COUNTERSUNK HOLE WILL BE UP NOTE: TOP OF .312" REAMED HOLE MUST CLEAR TOP OF VISE JAW. REFER TO FIGURE 1 NOTE: APPROXIMATELY 3/8" OF WORKPIECE WILL BE FASTENED IN VISE 3. ALIGN WORKPIECE NOTE: DIAL INDICATOR OR COMBINATION SQUARE MAY BE USED
3. MACHINE SLOT	1. CENTER WORKPIECE WITH CUTTER NOTE: HOLD 13/32" FROM EDGE OF WORKPIECE TO SIDE OF SLITTING SAW. REFER TO FIGURE 1 2. MACHINE SLOT TO DEPTH NOTE: TAKE LIGHT CUTS TO PREVENT WORKPIECE FROM MOVING

STEPS	KEY POINTS
	3. REMOVE WORKPIECE AND BURR ALL EDGES
	4. INSPECT WORKPIECE. HOLD ALL SPECIFIED DIMENSIONS
	5. SECURE MILLING MACHINE
	HOLD FOR ASSEMBLY

SKETCHES: DRAWING #3 B: SURFACE GAGE

REFERENCES: REF. #3, PP. 229-270
REF. #4, PP. 317-354
REF. #5, PP. 223-241

VII-C-2(J)

JOB SHEET
ON
ENGINE LATHE

JOB: SURFACE GAGE

MATERIALS:
PART #23: SHOULDER SCREW - 1/2" X 2" C.R. ROUND
PART # 8: SHOULDER SCREW - 5/16" X 1 1/2" C.R. ROUND

TOOLS AND EQUIPMENT: ENGINE LATHE, COLLET ATTACHMENT, 5/16" COLLET, 1/2" COLLET, 31/64" COLLET (31/64" COLLET NOT REQUIRED IF 1/2" RUBBER FLEX COLLET IS USED), R.H. FACING TOOL, #1 CENTERDRILL, DRILL CHUCK AND KEY, LIVE CENTER, 6" RULE, 0-1" MICROMETER, LAYOUT INK, SCRIBE, SCREW PITCH GAGE, CENTER GAGE, MILL FILE, AND 6-32 N.C. NUT TO BE USED AS A GAGE

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 135-184; REF. #4, PP. 217-282; REF. #5, PP. 141-182. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE AND UPON COMPLETION OF TASKS.

PROCEDURES AND/OR TASKS:

VII-A-1(TS)	CHECK ENGINE LATHE FOR PROPER OPERATING CONDITION
*VII-C-2(TS)	MACHINE SHOULDER SCREW PART #23
*VII-C-2a(TS)	MACHINE SHOULDER SCREW PART # 8
	ROUTE TO VERTICAL MILLING MACHINE

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS

1. OPERATING CONDITION OF ENGINE LATHE
2. SETUP OF COLLET ATTACHMENT
3. SETUP OF TOOLING AND WORKPIECE
4. ALL DIMENSIONS HELD TO SPECIFICATIONS
5. OBSERVANCE OF ALL SAFE WORKING HABITS
6. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR MACHINE TOOLS, EQUIPMENT, SUPPLIES, AND STANDARDS

TASK SHEET VII-C-2(TS)

TASK:	MACHINE SHOULDER SCREW PART #23
JOB:	SURFACE GAGE
TRADE:	MACHINIST
TOOLS AND MATERIALS:	ENGINE LATHE, COLLET ATTACHMENT, 1/2" COLLET, 31/64" COLLET, R. H. FACING TOOL, R. H. TURNING TOOL, 6" RULE, 0-1" MICROMETER, TAILSTOCK CHUCK AND KEY, #1 CENTERDRILL, LIVE CENTER, 60° THREADING TOOL, MILL FILE, LAYOUT INK, SCRIBE, SCREW PITCH GAGE, 6-32 N.C. NUT FOR GAGE, AND PART #23 - 1/2" X 2" C. R. ROUND

TASK BREAKDOWN:

STEPS	KEY POINTS
1. CHUCK WORKPIECE	1. INSTALL 1/2" COLLET IN COLLET ATTACHMENT 2. SET UP WORKPIECE IN COLLET NOTE: ALLOW 1 1/4" OF WORKPIECE TO EXTEND OUT 3. CHECK FOR WORKPIECE RUNNING TRUE CAUTION: ONLY .015" WILL BE REMOVED FROM DIAMETER. WORKPIECE MUST INDICATE LESS THAN .007"
2. FACE AND TURN 31/64" DIAMETER	1. SET UP FACING TOOL 2. FACE END FOR CLEANUP 3. REPLACE FACING TOOL WITH R. H. TURNING TOOL 4. TURN DIAMETER TO .484" NOTE: HOLD MINIMUM 31/32" LENGTH 5. BURR EDGES AND INSPECT
3. LOCATE CENTER LINE FOR DRILLED AND REAMED HOLE	1. INK TURNED DIAMETER ABOUT 3/8" FROM END NOTE: INK ALL OF THE WAY AROUND 2. POSITION SCRIBE AGAINST TOOL HOLDER EXTENDING OUT ABOUT 1/2" FROM HOLDER NOTE: DIRECT POINT SLIGHTLY BELOW CENTER 3. MOVE CARRIAGE UNTIL SCRIBER POINT IS EXACTLY 11/32" FROM END

STEPS	KEY POINTS
	4. TURN MACHINE ON NOTE: HOLD SCRIBE FIRMLY AGAINST TOOL HOLDER
	5. SCRIBE LINE LIGHTLY CAUTION: DO NOT LET SCRIBE POINT UPWARD AND GRAB ON THE STOCK NOTE: THE FACING TOOL OR THREADING TOOL POINT CAN BE USED INSTEAD OF SCRIBE
	6. BURR AND REMOVE WORKPIECE
4. RECHUCK WORKPIECE	1. INSTALL 31/64" COLLET NOTE: A 1/2" OR 9/16" RUBBER FLEX COLLET MAY BE USED
	2. SET UP WORKPIECE IN COLLET NOTE: CHUCK THE 31/64" END INTO COLLET WITH 3/4" OF WORKPIECE IN COLLET
	3. CHECK FOR RUNNING TRUE
5. FACE AND CENTER-DRILL END	1. INSTALL R. H. FACING TOOL
	2. FACE END NOTE: HOLD 1" FROM TURN SHOULDER, 1 31/32" OVERALL LENGTH AS SPECIFIED
	3. CENTERDRILL END
	4. REMOVE DRILL CHUCK
	5. INSERT LIVE CENTER
	6. POSITION LIVE CENTER AGAINST WORKPIECE NOTE: LUBRICATE CENTER
6. TURN 19/64" DIAMETER	1. SET UP R. H. TURNING TOOL
	2. TURN DIAMETER TO .297" NOTE: HOLD 1" LENGTH NOTE: HOLD SQUARE SHOULDER
7. SET UP AND TURN .138" DIAMETER	1. TURN DIAMETER TO .138" DIAMETER
	2. HOLD 11/16" LENGTH
8. TURN 6-32 N. C. THREAD	1. SET UP THREADING STOOL NOTE: CHECK FOR POSITION WITH CENTER OF WORKPIECE
	2. TURN THREAD TO DEPTH NOTE: HOLD 7/16" FULL THREAD
	3. CLEAN THREADS

STEPS	KEY POINTS
	4. REMOVE LIVE CENTER FROM WORKPIECE 5. CHECK WITH 6-32 N. C. NUT 6. FILE RADIUS ON .138" END CAUTION: DO NOT REMOVE CENTER-DRILLED HOLE OR DAMAGE THREADS 7. CHECK WITH GAGE AND REMOVE WORKPIECE 8. SECURE TOOLS AND MACHINE ROUTE TO VERTICAL MILLING MACHINE

SKETCHES: DRAWING #3-C: SURFACE GAGE

REFERENCES: REF. #3, PP. 135-184
REF. #4, PP. 217-282
REF. #5, PP. 141-182

TASK SHEET

VII-C-2a(TS)

TASK: MACHINE SHOULDER SCREW PART # 8

JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: ENGINE LATHE, COLLET ATTACHMENT, 5/16" COLLET, DRILL CHUCK, #1 CENTERDRILL, LIVE CENTER, R. H. FACING TOOL, R. H. TURNING TOOL, 60° THREADING TOOL, SCREW PITCH GAGE, CENTER GAGE, MILL FILE, 6-32 N. C. NUT TO BE USED AS A GAGE, AND PART #8: 5/16" X 1 1/2" C. R.

TASK BREAKDOWN:

STEPS	KEY POINTS
1. CHUCK WORKPIECE	1. INSTALL 5/16" COLLET IN COLLET ATTACHMENT 2. SET UP WORKPIECE IN COLLET NOTE: WORKPIECE TO EXTEND OUT 3/4" 3. CHECK WORKPIECE FOR RUNNING TRUE CAUTION: WORKPIECE MUST INDICATE TO LESS THAN .007" SINCE ONLY .015" WILL BE REMOVED
2. TURN 19/64" DIAMETER	1. FACE END FOR CLEANUP ONLY 2. TURN DIAMETER TO .297" X 5/8" LONG NOTE: LENGTH WILL BE SHORTENED LATER CAUTION: ONLY .015" WILL BE REMOVED FROM DIAMETER 3. BURR EDGES 4. REMOVE WORKPIECE FROM COLLET
3. RECHECK WORKPIECE	1. INSTALL 19/64" COLLET UNLESS 5/16" RUBBER FLEX COLLET IS USED 2. MOUNT WORKPIECE IN COLLET NOTE: ENTIRE LENGTH OF 19/64" DIAMETER WILL BE CLAMPED IN COLLET
4. FACE AND CENTERDRILL END	1. FACE END OF WORKPIECE. HOLD 1 3/8" LENGTH 2. INSTALL DRILL CHUCK AND CENTERDRILL 3. CENTERDRILL WORKPIECE

STEPS	KEY POINTS
	NOTE: CENTERDRILL ONLY DEEP ENOUGH TO PERMIT SUPPORT FROM LIVE CENTER 4. REMOVE DRILL CHUCK 5. INSERT LIVE CENTER
5. TURN .250" DIAMETER	1. LOOSEN COLLET 2. SLIDE WORKPIECE OUT NOTE: HOLD 1/4" FOR HOLDING WORKPIECE 3. SLIDE LIVE CENTER AND TAILSTOCK UP TO CENTERDRILLED HOLE NOTE: LUBRICATE CENTER 4. TURN DIAMETER TO SPECIFIED SIZE NOTE: HOLD .250" DIAMETER TO 1 1/16" LENGTH
6. TURN .138" DIAMETER	1. TURN WORKPIECE TO SPECIFIED DIAMETER 2. HOLD .138" DIAMETER TO SPECIFIED 15/32" LENGTH
7. TURN 6-32 N. C. THREAD	1. SET UP THREADING TOOL 2. TURN THREAD TO DEPTH NOTE: HOLD 7/16" FULL THREAD LENGTH 3. REMOVE LIVE CENTER FROM WORKPIECE 4. CHECK THREADS WITH 6-32 N. C. NUT 5. FILE RADIUS ON END CAUTION: DO NOT REMOVE CENTERDRILLED HOLE OR DAMAGE THREADS 6. RECHECK THREADS WITH NUT 7. REMOVE WORKPIECE 8. SECURE TOOLS AND MACHINE ROUTE TO BENCH

SKETCHES: DRAWING #3-C: SURFACE GAGE

REFERENCES: REF. #3, PP. 135-184
REF. #4, PP. 217-282
REF. #5, PP. 141-182

IX-C-4(J)

JOB SHEET
ON
VERTICAL MILLING MACHINE

JOB: SURFACE GAGE

MATERIAL: PARTS #23 AND #8: SHOULDER SCREWS AS MACHINED ON THE ENGINE LATHE

TOOLS AND EQUIPMENT: VERTICAL MILLING MACHINE, WIGGLER (CENTER FINDER), DIVIDING HEAD WITH UNIVERSAL CHUCK, DRILL CHUCK FOR VERTICAL MILL, 5/16" DRILL, .328" REAMER (21/64"), 1/8" DRILL, .141" REAMER (9/64"), 1/4" END MILL, 1/4" END MILL HOLDER, 6" RULE, 0-1: MICROMETER, MILL FILE, AND 9/64" DRILL

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 229-283, REF. #4, PP. 317-370, REF. #5, PP. 223-290. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE AND UPON COMPLETION OF TASKS

PROCEDURES AND/OR TASKS:

PART #23

IX-A-1(TS)	CHECK VERTICAL MILLING MACHINE FOR PROPER OPERATING CONDITION
IX-A-1a(TS)	SET UP DIVIDING HEAD
*IX-C-4(TS)	DRILL AND REAM - 2 HOLES PERPENDICULAR TO EACH OTHER
*IX-C-4a(TS)	MILL TWO FLATS PARALLEL TO EACH OTHER NOTE: 11/64" WIDE - 180° APART

PART #8

IX-C-4b(TS)	DRILL 9/64" HOLE
IX-C-4c(TS)	MILL FLATS NOTE: HOLD 3/16" WIDE - 180° APART PERPENDICULAR TO 9/64" HOLE HOLD FOR ASSEMBLY

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS.

1. OPERATING CONDITION OF VERTICAL MILLING MACHINE
2. PROPER SETUP OF DIVIDING HEAD
3. PROPER INSTALLATION OF TOOLING AND WORKPIECE
4. ALL DIMENSIONS HELD TO SPECIFICATIONS
5. OBSERVANCE OF ALL SAFE WORKING HABITS
6. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR MACHINE TOOLS, EQUIPMENT, SUPPLIES, AND STANDARDS

TASK SHEET

IX-C-4(TS)

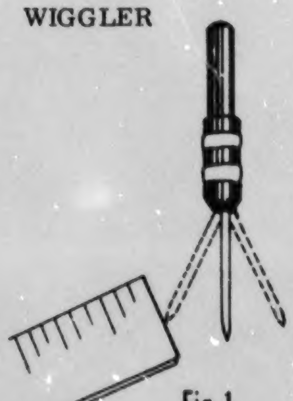
TASK: DRILL AND REAM - 2 HOLES PERPENDICULAR TO EACH OTHER

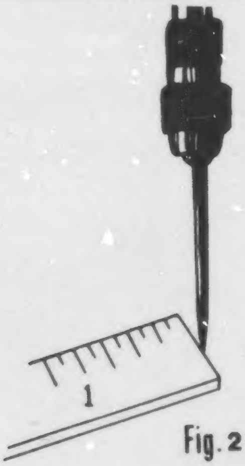
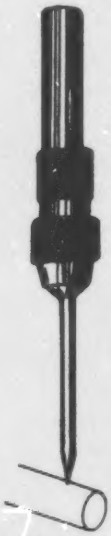
JOB: SURFACE GAGE

TRADE: MACHINISTS

TOOLS AND MATERIALS: VERTICAL MILLING MACHINE, DIVIDING HEAD, WITH UNIVERSAL CHUCK, WIGGLER, DRILL CHUCK, 5/16" DRILL, .328" REAMER (21/64"), 1/8" DRILL, 141" REAMER (9/64"), #1 CENTER DRILL, DIAL INDICATOR, MILL FILE, AND PART #23: SHOULDER SCREW AS PREVIOUSLY MACHINED

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP DIVIDING HEAD	1. MOUNT DIVIDING HEAD ON MILL TABLE NOTE: CENTER AXIS OF CHUCK WILL BE DIRECTED IN THE SAME DIRECTION AS THE MILL TABLE 2. MOUNT UNIVERSAL CHUCK NOTE: CLEAN SPINDLE THREADS 3. TIGHTEN T-BOLTS
2. INSTALL WORKPIECE	1. PLACE WORKPIECE IN UNIVERSAL CHUCK NOTE: PLACE THREADED END INTO CHUCK ALLOWING ABOUT 5/8" OF LARGE DIAMETER TO EXTEND PAST CHUCK JAWS NOTE: LET MATERIAL EXTEND ONLY ENOUGH TO CLEAR FOR DRILLING AND REAMING 2. CHECK ALIGNMENT OF WORKPIECE WITH DIAL INDICATOR NOTE: ROTATE WORKPIECE ONE REVOLUTION AND CHECK LONGITUDINAL ALIGNMENT
3. INSTALL AND TRUE WIGGLER  Fig. 1	1. INSTALL DRILL CHUCK IN SPINDLE 2. INSTALL WIGGLER IN DRILL CHUCK 3. TURN SPINDLE ON 4. PLACE RULE AGAINST END OR EDGE OF WIGGLER. REFER TO FIG. 1 NOTE: RULE MAY BE PLACED ON DIVIDING HEAD FOR SUPPORT

STEPS	KEY POINTS
 Fig. 2	5. ADJUST RULE UNTIL WIGGLER POINT IS RUNNING TRUE. REFER TO FIG. 2 6. REMOVE RULE 7. TURN SPINDLE OFF
4. LOCATE CENTER OF 5/16" DRILLED HOLE  Fig. 3	1. ELEVATE TABLE UNTIL POINT OF WIGGLER IS ABOUT 1" ABOVE WORKPIECE 2. LOWER SPINDLE UNTIL WIGGLER IS ABOUT 1/8" ABOVE WORK NOTE: LOCK SPINDLE 3. ADJUST LONGITUDINAL AND CROSS FEED HANDWHEELS UNTIL WIGGLER POINT IS LOCATED DIRECTLY ON CENTER WITH HOLE LAYOUT. REFER TO FIG. 3 NOTE: LAYOUT FOR ONLY ONE HOLE IS REQUIRED NOTE: WIGGLER POINT WILL BE LOCATED ON CENTER OF WORKPIECE 11/32" FROM THE END PROTRUDING FROM CHUCK JAWS 4. LOCK CROSS FEED 5. LOCK LONGITUDINAL FEED 6. RAISE SPINDLE 7. REMOVE WIGGLER
5. SPOT CENTER LOCATION	1. INSTALL #1 CENTERDRILL 2. TURN SPINDLE ON NOTE: SPINDLE SPEED SHOULD BE RELATIVELY SLOW TO PREVENT CENTERDRILL FROM WALKING 3. CENTERDRILL WORKPIECE NOTE: DRILL ONLY DEEP ENOUGH TO PROVIDE PILOT FOR DRILL

STEPS	KEY POINTS
	4. RAISE SPINDLE AND REMOVE CENTERDRILL
6. DRILL 5/16" HOLE	1. SELECT AND INSPECT 5/16" DRILL 2. INSTALL DRILL IN DRILL CHUCK 3. SET SPINDLE SPEED AND FEED 4. DRILL HOLE THROUGH NOTE: KEEP DRILL LUBRICATED 5. REMOVE DRILL
7. REAM HOLE .328"	1. SELECT AND INSPECT .323" REAMER 2. INSTALL REAMER AS PER DRILL 3. SET SPINDLE SPEED AND FEED NOTE: SPINDLE SPEED ABOUT 2/3 THAT FOR DRILLING 4. REAM HOLE NOTE: LUBRICATE REAMER 5. REMOVE REAMER 6. INSPECT AND BURR HOLE
8. SPOT LOCATE, DRILL AND REAM 1/8" HOLE	1. ROTATE WORKPIECE 90° WITH DIVIDING HEAD CRANK 2. SET UP CENTERDRILL 3. SPOT CENTER LOCATION AS PER STEP #5 NOTE: CENTER OF HOLE WILL BE LOCATED AND PROVIDE PILOT FOR DRILL 4. REMOVE CENTERDRILL 5. INSTALL 1/8" DRILL 6. DRILL HOLE AS PER STEP #6 7. REMOVE DRILL 8. INSTALL 9/64" REAMER (141") 9. SET SPINDLE SPEED AND FEED 10. REAM HOLE TO SIZE 11. REMOVE REAMER 12. BURR AND INSPECT WORKPIECE SETUP FOR NEXT MILL OPERATION

SKETCHES: DRAWING #3-C: SURFACE GAGE

REFERENCES: REF. #3, PP. 229-283
REF. #4, PP. 317-370
REF. #5, PP. 223-290

TASK SHEET IX-C-4a(TS)

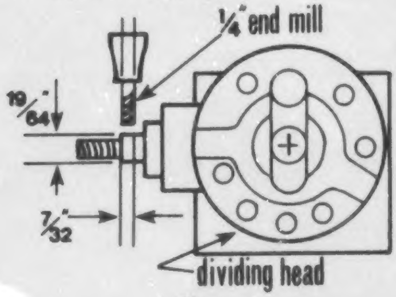
TASK: MILL TWO FLATS PARALLEL TO EACH OTHER

JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: VERTICAL MILLING MACHINE, 1/4" END MILL, 1/4" END MILL HOLDER, 6" RULE, 0-1" MICROMETER, DIVIDING HEAD WITH UNIVERSAL CHUCK, AND MILL FILE

TASK BREAKDOWN:

STEPS	KEY POINTS
1. INSTALL WORKPIECE	1. MOUNT WORKPIECE IN UNIVERSAL CHUCK NOTE: LARGE DIAMETER WILL BE POSITIONED IN CHUCK 2. PLACE THE 5/16" HOLE PERPENDICULAR TO TABLE NOTE: 11/64" FLATS NEED NOT BE EXACT WITH RELATIONSHIP TO HOLES. COULD BE AS MUCH AS 45° REMOVED
2. SET UP 1/4" END MILL	1. SELECT AND INSPECT END MILL NOTE: MUST NOT HAVE A RADIUS ON THE CUTTING EDGE 2. CHECK END MILL FOR RUNNING TRUE
3. MILL FIRST FLAT  Fig. 1	1. RAISE TABLE UNTIL WORKPIECE IS ALMOST TOUCHING END MILL 2. ADJUST LONGITUDINAL FEED AND CROSS FEED UNTIL END MILL IS POSITIONED CORRECTLY. REFER TO FIG. 1 NOTE: HOLD INSIDE EDGE OF END MILL 7/32" FROM 19/64" SHOULDER AS PER FIG. 1 3. MACHINE FLAT NOTE: HOLD 1/16" DEEP BY 11/64" WIDTH 4. LEAVE TABLE POSITION AS IS
4. MILL SECOND FLAT	1. ROTATE WORKPIECE 180° BY TURNING DIVIDING HEAD CRANK 2. MACHINE SECOND FLAT. HOLD 11/64" FLAT 3. REMOVE WORKPIECE AND BURR EDGES 4. INSPECT WORKPIECE

STEPS	KEY POINTS
	5. SECURE TOOL AND MACHINE HOLD FOR ASSEMBLY

SKETCH: DRAWING #3-C: SURFACE GAGE

REFERENCES: REF. #3, PP. 229-283
REF. #4, PP. 317-370
REF. #5, PP. 223-290

VII-C-3(J)

JOB SHEET
ON
ENGINE LATHE

JOB:	SURFACE GAGE
MATERIALS:	PART #13: PRESSURE SLEEVE - 3/4" X 2" C. R. ROUND NOTE: 1" OF MATERIAL IS EXCESS MATERIAL
TOOLS AND EQUIPMENT:	ENGINE LATHE, COLLET ATTACHMENT, 3/4" COLLET, FACING TOOL, CENTERDRILL, DRILL CHUCK AND KEY, 0-1" MICROMETER, 6" RULE, MILL FILE, R. H. TURNING TOOL, 31/64" DRILL, 1/2" REAMER, CUT-OFF TOOL, INDEPENDENT CHUCK, DIAL INDICATOR, LAYOUT TABLE, LAYOUT DYE, V-BLOCK, AND HEIGHT GAGE
GENERAL INSTRUCTIONS:	BEFORE BEGINNING THIS JOB READ REF. #3, PP. 135-184; REF. #4, PP. 217-282; REF. #5, PP. 141-182. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE NOTE: UPON COMPLETION OF FACING, TURNING, AND REAMING OPERATION, ROUTE TO MILL BEFORE CUTTING OFF WASTE STOCK
PROCEDURES AND/OR TASKS:	VII-A-1(TS) CHECK ENGINE LATHE FOR PROPER OPERATING CONDITIONS VII-C-2(TS) SET UP COLLET ATTACHMENT *VII-C-3(TS) MACHINE PRESSURE SLEEVE ROUTE TO MILLING MACHINE
CHECK POINTS:	STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS 1. CHECK PROPER OPERATING CONDITION OF LATHE 2. SETUP OF WORKPIECE AND TOOLING CORRECTLY MADE 3. ALL DIMENSIONS HELD TO SPECIFICATIONS 4. OBSERVANCE OF ALL SAFETY PROCEDURES 5. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR LAYOUT TOOLS, EQUIPMENT, AND STANDARDS

TASK SHEET VII-C-3(TS)

TASK: MACHINE PRESSURE SLEEVE

JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: ENGINE LATHE, COLLET ATTACHMENT, 3/4" COLLET, FACING TOOL, R. H. TURNING TOOL, DRILL CHUCK, CENTERDRILL, 0-1" MICROMETER, 6" RULE, 31/64" DRILL, 1/2" REAMER, LAYOUT TABLE, LAYOUT DYE, HEIGHT GAGE, V-BLOCK, SCRIBE AND PART #13: PRESSURE SLEEVE - 3/4" X 2" C. R. ROUND

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP WORKPIECE	1. INSTALL 3/4" COLLET IN COLLET ATTACHMENT 2. INSERT WORKPIECE INTO 3/4" COLLET NOTE: WORKPIECE EXTENDING OUT 1 1/4" FROM COLLET 3. CHECK FOR RUNNING TRUE NOTE: EXACTNESS IS NOT ESSENTIAL AS APPROXIMATELY .090" WILL BE REMOVED
2. FACE AND TURN .656" DIAMETER	1. SET UP FACING TOOL 2. FACE END FOR CLEANUP 3. REPLACE FACING TOOL WITH R. H. TURNING TOOL 4. TURN DIAMETER TO .656" NOTE: HOLD LENGTH TO 1 1/4" 5. INSPECT AND BURR EDGES 6. WITH POINT OF TOOL OR SCRIBER LOCATE CENTER LINE FOR THE DRILLED HOLES 5/16" FROM END AS PER VII-C-2a (TS), STEP #3
3. DRILL HOLE 31/64"	1. INSTALL DRILL CHUCK AND CENTERDRILL 2. CENTERDRILL HOLE NOTE: THIS WILL PROVIDE PILOT FOR 31/64" DRILL 3. REPLACE CENTERDRILL WITH 31/64" DRILL 4. DRILL HOLE TO DEPTH

STEPS	KEY POINTS
	HOLD: 1 1/4" DEPTH MINIMUM CAUTION: KEEP DRILL OILED AND CHIPS REMOVED 5. REMOVE DRILL
4. REAM HOLE	1. INSERT 1/2" CHUCKING REAMER IN CHUCK NOTE: INSPECT REAMER FOR CONDITION AND SIZE 2. SET SPINDLE SPEED APPROXIMATELY 2/3 THE SPEED FOR DRILLING 3. REAM HOLE. HOLD 1 1/4" DEPTH CAUTION: BECAUSE OF A BLIND HOLE, CHIPS WILL BALL UP IN THE END. LUBRICATE FREELY AND CLEAN CHIPS OUT PRIOR TO COMPLETION OF REAMING OPERATION 4. BURR EDGE OF HOLE CAUTION: DO NOT USE ABRASIVE WRAPPED AROUND FINGER 5. ROUTE TO BENCH FOR LAYOUT NOTE: DO NOT CUT OFF EXCESS MATERIAL
5. LAYOUT CENTERS FOR REAMED HOLES	1. INK WORKPIECE 2. MOUNT WORKPIECE IN V-BLOCK NOTE: CLAMP WORKPIECE WITH V-BLOCK CLAMP 3. SET HEIGHT GAGE FOR THE CENTER LINE HEIGHT OF WORKPIECE 4. SCRIBE LONGITUDINAL CENTER LINE TO INTERSECT LINE SCRIBED WHILE CHUCK IS IN THE LATHE NOTE: THIS WILL LOCATE CENTER FOR ONE HOLE. LOCATION OF THE OTHER IS NOT REQUIRED NOTE: DO NOT CENTERPUNCH 5. ROUTE TO VERTICAL MILL FOR DRILLING AND REAMING TWO HOLES NOTE: REFER TO IX-C-4(TS). COMPLETE TASK AND ROUTE BACK TO ENGINE LATHE FOR FOLLOWING STEPS
6. INSTALL WORKPIECE	1. REMOVE COLLET ATTACHMENT 2. INSTALL INDEPENDENT CHUCK 3. CHUCK WORKPIECE

STEPS	KEY POINTS
	NOTE: TRUE WORKPIECE WITH DIAL INDICATOR NOTE: CHECK FOR END RUNOUT ALSO
7. TURN 1/8" X 30°	1. INSTALL TURNING TOOL 2. SET COMPOUND REST FOR 30° ANGLE 3. TURN TO SIZE NOTE: HOLD 1/8" LENGTH NOTE: HOLD 1" LENGTH ON WORKPIECE CAUTION: THE WORKPIECE WILL BE ALMOST CUT IN TWO 4. CUT OFF WORKPIECE 5. BURR AND INSPECT HOLD FOR INSPECTION

SKETCHES: DRAWING #3-D: SURFACE GAGE

REFERENCES: REF. #3, PP. 135-184
REF. #4, PP. 217-282
REF. #5, PP. 141-182

IX-C-4(J)

JOB SHEET
ON
VERTICAL MILLING MACHINE

JOB: SURFACE GAGE

MATERIALS: PART #13: PRESSURE SLEEVE AS MACHINED IN PREVIOUS TASK

TOOLS AND EQUIPMENT: VERTICAL MILLING MACHINE, DIVIDING HEAD WITH UNIVERSAL CHUCK, DRILL CHUCK FOR VERTICAL MILLING MACHINE, WIGGLER OR CENTER FINDER, 5/16" DRILL, 21/64" REAMER (.328"), 1/8" DRILL, 9/64" REAMER (.141"), AND MILL FILE

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 229-280; REF. #4, PP. 317-354; REF. #5, PP. 223-241. CHECK WITH THE INSTRUCTOR BEFORE OPERATING MACHINES

NOTE: UPON COMPLETION OF OPERATIONS, ROUTE TO THE ENGINE LATHE FOR CUTTING WASTE STOCK OFF

PROCEDURES AND/OR TASKS:

IX-A-1(TS)	CHECK VERTICAL MILLING MACHINE FOR PROPER OPERATING CONDITION
IX-C-1(TS)	SET UP DIVIDING HEAD
*IX-C-4(TS)	DRILL AND REAM HOLES
	ROUTE TO ENGINE LATHE

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASK

1. CHECK VERTICAL MILL FOR PROPER OPERATING CONDITION
2. CHECK DIVIDING HEAD FOR SETUP AND TRUE ALIGNMENT
3. PROPER INSPECTION AND SELECTION OF TOOLING
4. ALL DIMENSIONS HELD TO SPECIFICATIONS AND TOLERANCE
5. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS
6. OBSERVANCE OF ALL SAFETY REGULATIONS

TASK SHEET IX-C-4(TS)

TASK:	DRILL AND REAM HOLES
JOB:	SURFACE GAGE
TRADE:	MACHINIST
TOOLS AND MATERIALS:	VERTICAL MILLING MACHINE, DIVIDING HEAD WITH UNIVERSAL CHUCK, DRILL CHUCK FOR VERTICAL MILL, WIGGLER OR CENTER FINDER, 5/16" DRILL, 21/64" REAMER (.328"), MILL FILE, 1/8" DRILL, 9/64" REAMER (.141"), AND PART #13: PRESSURE SLEEVE - AS PREVIOUSLY MACHINED

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP DIVIDING HEAD	1. MOUNT DIVIDING HEAD ON MILL TABLE NOTE: CENTER AXIS OF CHUCK WILL BE DIRECTED IN THE SAME DIRECTION AS THE MILL TABLE 2. MOUNT UNIVERSAL CHUCK 3. TIGHTEN T-BOLTS
2. INSTALL WORKPIECE	1. PLACE WORKPIECE INTO CHUCK NOTE: WORKPIECE IS CHUCKED WITH THE WASTE PART IN THE CHUCK 2. TIGHTEN CHUCK 3. ROTATE DIVIDING HEAD UNTIL CENTER FOR 5/16" HOLE IS UPRIGHT NOTE: CENTER AXIS WILL BE PERPENDICULAR TO TABLE
3. TRUE WORKPIECE	1. CHECK ALIGNMENT OF WORKPIECE WITH DIAL INDICATOR NOTE: CHECK LONGITUDINAL ALIGNMENT AND ROTATE WORKPIECE ONE REVOLUTION AND CHECK FOR TRUE
4. LOCATE CENTER OF HOLE	1. INSTALL WIGGLER AND TRUE NOTE: REFER TO: IX-C-3(TS), STEP #3 2. TURN MACHINE OFF 3. ADJUST LONGITUDINAL, VERTICAL, AND CROSS FEED OF TABLE UNTIL WIGGLER POINT IS LOCATED IN THE CENTER LAYOUT OF HOLE 4. LOCK TABLE 5. REMOVE WIGGLER

STEPS	KEY POINTS
	CAUTION: DO NOT CHANGE ANY TABLE SETTINGS
5. DRILL 5/16" HOLE	1. SET UP 5/16" DRILL NOTE: INSPECT SIZE AND CONDITION 2. SET SPINDLE SPEED AND FEED NOTE: USE SLOW SPEED TO START HOLE TO PREVENT DRILL FROM WALKING NOTE: CENTERDRILL MAY BE USED TO DRILL PILOT. REFER TO: IX-C-3(TS), STEP #5 3. DRILL THROUGH NOTE: KEEP DRILL LUBRICATED 4. REMOVE DRILL 5. BURR HOLE NOTE: DO NOT MOVE WORKPIECE OR TABLE POSITION
6. REAM HOLE TO .328"	1. INSTALL 21/64" REAMER NOTE: REAMER SHOULD MEASURE .328" 2. SET SPINDLE SPEED AND FEED 3. REAM HOLE TO SIZE 4. REMOVE REAMER NOTE: DO NOT CHANGE WORKPIECE POSITION
7. DRILL AND REAM .141" HOLE	1. INDEX DIVIDING HEAD 90° NOTE: .328" HOLE WILL BE IN A HORIZONTAL POSITION 2. SET UP AND DRILL 1/8" HOLE AS PER STEP #5 3. REMOVE DRILL 4. SET UP AND REAM .141" HOLE AS PER STEP #6 5. REMOVE REAMER 6. BURR AND INSPECT WORKPIECE 7. SECURE TOOLS AND MACHINE ROUTE TO ENGINE LATHE

SKETCHES: DRAWING #3-D: SURFACE GAGE

REFERENCES: REF. #3, PP. 229-280
REF. #4, PP. 317-354
REF. #5, PP. 223-241

VII-C-4(J)

JOB SHEET
ON
ENGINE LATHE

JOB: SURFACE GAGE

MATERIALS: PART #10: PRESSURE CUP - 1/2" X 1 7/16" C. R. ROUND
NOTE: 1" OF MATERIAL IS EXCESS MATERIAL

TOOLS AND EQUIPMENT: ENGINE LATHE, COLLET ATTACHMENT, 1/2" COLLET, FACING TOOL, TURNING TOOL, DRILL CHUCK, CENTER-DRILL, 0-1" MICROMETER, 6" RULE, 17/64" DRILL, LAYOUT BENCH, LAYOUT INK, HEIGHT GAGE, CUT-OFF TOOL, INDEPENDENT CHUCK, DIAL INDICATOR, V-BLOCKS WITH CLAMP AND MILL FILE

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 135-184; REF. #4, PP. 217-282; REF. #5, PP. 141-182. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE
NOTE: UPON COMPLETION OF FACING, TURNING, DRILLING, AND CENTER LAYOUT, ROUTE TO VERTICAL MILLING MACHINE BEFORE CUTTING EXCESS MATERIAL OFF

PROCEDURES AND/OR TASKS:

VII-A-1(TS)	CHECK ENGINE LATHE FOR PROPER OPERATING CONDITIONS
VII-C-1(TS)	SET UP COLLET ATTACHMENT
*VII-C-4(TS)	MACHINE PRESSURE CUP

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS

1. CHECK PROPER OPERATING CONDITION OF LATHE
2. CORRECT SETUP OF TOOLING AND WORKPIECE MADE
3. ALL DIMENSIONS HELD TO SPECIFICATIONS AND TOLERANCE
4. OBSERVANCE OF ALL SAFETY PROCEDURES
5. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR LAYOUT, TOOLS, EQUIPMENT, AND STANDARDS

TASK SHEET

VII-C-4(TS)

TASK: MACHINE PART #10: PRESSURE CUP

JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: ENGINE LATHE, COLLET ATTACHMENT, 1/2" COLLET, FACING TOOL, R. H. TURNING TOOL, DRILL CHUCK, CENTERDRILL, 0-1" MICROMETER, 6" RULE, 17/64" DRILL, 5/16" DRILL, LAYOUT BENCH, LAYOUT INK, HEIGHT GAGE, CUT-OFF TOOL, INDEPENDENT CHUCK, DIAL INDICATOR, V-BLOCKS WITH CLAMP MILL FILE, AND PART #10: PRESSURE CUP, 1/2" X 1 7/16" C. R. ROUND

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP WORKPIECE	1. INSTALL 1/2" COLLET IN COLLET ATTACHMENT 2. INSERT WORKPIECE IN 1/2" COLLET NOTE: WORKPIECE TO EXTEND OUT 5/8" 3. CHECK FOR RUNNING TRUE
2. FACE AND TURN TO .406" DIAMETER	1. SET UP FACING TOOL NOTE: FACE TO CLEAN UP 2. REPLACE FACING TOOL WITH TURNING TOOL 3. TURN DIAMETER TO SIZE NOTE: HOLD TO .406" X 5/8" LENGTH 4. BURR EDGES 5. SCRIBE CENTER LINE FOR 9/64" DRILLED HOLE 1/8" FROM EDGE NOTE: REFER TO VII-C-2a(TS), STEP #3
3. DRILL 17/64" HOLE	1. INSTALL DRILL CHUCK AND CENTERDRILL 2. CENTERDRILL HOLE NOTE: THIS PROVIDES PILOT FOR 17/64" DRILL 3. REMOVE CENTER DRILL AND INSTALL 17/64" DRILL 4. DRILL TO DEPTH NOTE: HOLD 5/8" DEEP 5. REMOVE DRILL 6. INSPECT HOLE SIZE

STEPS	KEY POINTS
4. DRILL HOLE 5/16"	1. INSTALL 5/16" DRILL 2. DRILL TO DEPTH NOTE: HOLD 11/32" DEPTH 3. BURR EDGES 4. REMOVE DRILL 5. ROUTE TO BENCH FOR LAYOUT OF HOLE CENTER
5. LAYOUT CENTER FOR 9/16" DRILLED HOLE	1. REFER TO VII-C-3(TS), STEP #5 NOTE: DO NOT CENTERPUNCH CENTER 2. ROUTE TO VERTICAL MILL FOR DRILLING 9/64" HOLE NOTE: REFER TO IX-C-4(TS). COMPLETE TASK AND ROUTE BACK TO ENGINE LATHE FOR FOLLOWING STEPS
6. CHUCK WORKPIECE IN 4-JAW CHUCK	REFER TO VII-C-3(TS), STEP #6
7. TURN 1/16" X 30° BEVEL	REFER TO VII-C-3(TS), STEP #7
8. CUT WORKPIECE TO LENGTH	1. INSTALL CUT-OFF TOOL 2. CUT OFF WORKPIECE NOTE: HOLD 7/16" LENGTH HOLD FOR ASSEMBLY

SKETCHES: DRAWING #3-D: SURFACE GAGE

REFERENCES:
REF. #3, PP. 135-184
REF. #4, PP. 217-282
REF. #5, PP. 141-182

IX-C-5(J)

JOB SHEET
ON
VERTICAL MILLING MACHINE

JOB: SURFACE GAGE

MATERIALS: PART #10: PRESSURE CUP AS MACHINED IN PREVIOUS TASK

TOOLS AND EQUIPMENT: VERTICAL MILLING MACHINE, DIVIDING HEAD WITH UNIVERSAL CHUCK, DRILL CHUCK FOR VERTICAL MILLING MACHINE, WIGGLER OR CENTER FINDER, 9/64" DRILL, AND MILL FILE

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 229-280; REF. #4, PP. 317-354; REF. #5, PP. 223-241. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINES

NOTE: UPON COMPLETION OF TASK, ROUTE TO ENGINE LATHE FOR CUTTING OFF WASTE MATERIAL

PROCEDURES AND/OR TASK:

IX-A-1(TS)	CHECK VERTICAL MILLING MACHINE FOR PROPER OPERATING CONDITION
IX-C-1(TS)	SET UP DIVIDING HEAD
*IX-C-5(TS)	DRILL 9/64" HOLE
	ROUTE TO ENGINE LATHE

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASK

1. CHECK VERTICAL MILL FOR PROPER OPERATING CONDITION
2. CHECK DIVIDING HEAD FOR SETUP AND TRUE ALIGNMENT
3. PROPER INSPECTION AND SELECTION OF TOOLING
4. ALL DIMENSIONS HELD TO SPECIFICATIONS AND TOLERANCE
5. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS

TASK SHEET

IX-C-5(TS)

TASK: DRILL 9/64" HOLE

JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: VERTICAL MILLING MACHINE, DIVIDING HEAD WITH UNIVERSAL CHUCK, DRILL CHUCK FOR VERTICAL MILL, WIGGLER OR CENTER FINDER, 9/64" DRILL, MILL FILE, AND PART #10 PRESSURE CUP AS PREVIOUSLY MACHINED

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP DIVIDING HEAD	REFER TO IX-C-4(TS), STEP #1
2. INSTALL WORKPIECE	1. PLACE WORKPIECE IN CHUCK NOTE: WORKPIECE IS CHUCKED WITH THE WASTE PART OF WORKPIECE IN CHUCK 2. TIGHTEN CHUCK
3. TRUE WORKPIECE	REFER TO IX-C-4(TS), STEP #3
4. LOCATE CENTER OF HOLE	1. INSTALL WIGGLER AND TRUE POINT NOTE: REFER TO: IX-C-3(TS), STEP #3 2. ADJUST LONGITUDINAL, VERTICAL, AND CROSS FEED UNTIL WIGGLER POINT IS LOCATED IN THE CENTER LAYOUT OF HOLE 3. LOCK TABLE 4. REMOVE WIGGLER CAUTION: DO NOT MOVE WORKPIECE OR TABLE
5. DRILL 9/64" HOLE	1. SET UP 9/64" HOLE NOTE: INSPECT SIZE AND CONDITION 2. SET SPINDLE SPEED AND FEED NOTE: USE SLOW SPEED TO START DRILL TO AVOID DRILL FROM WALKING NOTE: CENTERDRILL MAY BE USED TO DRILL PILOT HOLE. REFER TO IX-C-3(TS), STEP #5 3. DRILL HOLE THROUGH 4. BURR AND INSPECT 5. SECURE TOOLS AND MACHINE ROUTE ENGINE LATHE

STEPS		KEY POINTS
SKETCH:	DRAWING #3-D: SURFACE GAGE	
REFERENCES:	REF. #3, PP. 229-280 REF. #4, PP. 317-354 REF. #5, PP. 223-241	

VII-C-5(J)

JOB SHEET
ON
ENGINE LATHE

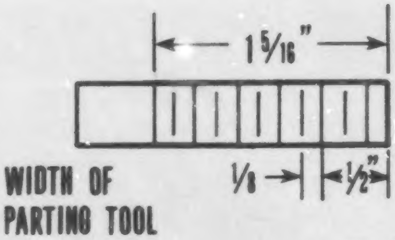
JOB:	SURFACE GAGE
MATERIALS:	PARTS #11 AND #12: PIVOT SCREWS "A" AND "B" - 5/16" X 2 1/2" C.R. ROUND NOTE: THIS WILL BE SUFFICIENT MATERIAL TO MAKE BOTH PARTS
TOOLS AND EQUIPMENT:	ENGINE LATHE, COLLET ATTACHMENT, 5/16" COLLET, FACING TOOL, TURNING TOOL, CENTER GAGE, 60° THREADING TOOL, SCREW PITCH GAGE, 6" RULE, AND MILL FILE
GENERAL INSTRUCTIONS:	BEFORE BEGINNING THIS JOB READ REF. #3, PP. 135-184; REF. #4, PP. 217-282; REF. #5, PP. 141-182. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE
PROCEDURES AND/OR TASK:	VII-A-1(TS) CHECK ENGINE LATHE FOR PROPER OPERATING CONDITION VII-C-2(TS) SET UP COLLET ATTACHMENT *VII-C-5(TS) MACHINE TWO PIVOT SCREWS ROUTE TO HORIZONTAL MILLING MACHINE
CHECKPOINTS:	STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS

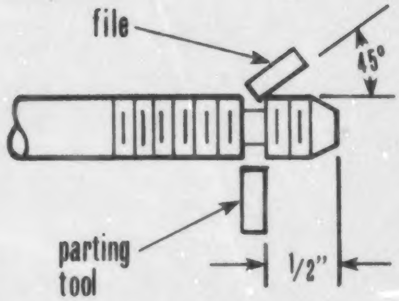
1. CHECK PROPER OPERATING CONDITION OF LATHE
2. CORRECT SETUP OF TOOLING AND WORKPIECE
3. ALL DIMENSIONS HELD TO SPECIFICATIONS
4. OBSERVANCE OF ALL SAFETY PROCEDURES
5. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR LAYOUT, TOOLS, EQUIPMENT, AND STANDARDS

TASK SHEET VII-C-5(TS)

TASK:	MACHINE TWO PIVOT SCREWS
JOB:	SURFACE GAGE
TRADE:	MACHINIST
TOOLS AND MATERIALS:	ENGINE LATHE, COLLET ATTACHMENT, 5/16" COLLET, FACING TOOL, TURNING TOOL, CENTER GAGE, 60° THREADING TOOL, SCREW PITCH GAGE, 6" RULE, MILL FILE, AND MATERIAL FOR PARTS #11 AND #12: PIVOT SCREWS "A" AND "B" - 5/16" X 2 1/2" C.R. ROUND NOTE: THIS WILL BE SUFFICIENT MATERIAL TO MACHINE BOTH PARTS

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP WORKPIECE	1. INSTALL COLLET ATTACHMENT 2. INSTALL 5/16" COLLET 3. INSERT WORKPIECE NOTE: 1 5/8" OF WORKPIECE TO EXTEND OUT FROM COLLET 4. CHECK FOR RUNNING TRUE NOTE: WORKPIECE MUST BE RUNNING TRUE SINCE NO MATERIAL WILL BE REMOVED FROM THE DIAMETER PRIOR TO THREADING OPERATION
2. FACE END	1. SET UP FACING TOOL 2. FACE END FOR CLEANUP ONLY
3. THREAD WORKPIECE NOTE: BOTH PARTS TO BE THREADED AT ONCE  Fig. 1	1. SET UP 60° THREADING TOOL 2. SET GEAR BOX FOR 24 PITCH THREAD 3. SET SPINDLE SPEED 4. THREAD WORKPIECE TO LENGTH NOTE: ALLOWANCE WILL BE MADE IN THREAD LENGTH FOR BOTH PARTS, CUTTING OFF AND FACING ENDS. SEE FIGURE 1 NOTE: TAKE LIGHT CUTS DUE TO FLEXIBILITY OF WORKPIECE 5. CLEAN AND BURR THREADS 6. INSPECT THREADS NOTE: A 5/16" - 24 NF NUT MAY BE USED AS A GAGE

STEPS	KEY POINTS
4. TURN 5/32" X 30°. BEVEL	1. SET UP TURNING TOOL 2. SET COMPOUND REST FOR ANGLE 3. TURN BEVEL NOTE: HOLD 5/32" LENGTH 4. INSPECT THREAD FOR DAMAGE
5. CUT OFF PART #11 NOTE: FILE 1/32" X 45° BEVEL  Fig. 2	1. SET UP CUT-OFF TOOL NOTE: SET CUT-OFF TOOL ON CENTER AND PERPENDICULAR TO WORKPIECE 2. LOOSEN COLLET AND SLIDE WORKPIECE INTO COLLET NOTE: 5/8" EXTENDING OUT FOR PART #11 3. SET SPINDLE SPEED 4. CUT WORKPIECE OFF NOTE: HOLD 1/2" FROM END. SEE FIGURE 2 NOTE: FILE 1/32" X 45° CHAMFER WHEN CUT-OFF TOOL IS ABOUT 1/2 THE WAY THROUGH WORKPIECE. SEE FIGURE 2 NOTE: A BEVEL THIS SMALL DOES NOT REQUIRE A SETUP FOR TURNING THE BEVEL IF FILED CAREFULLY CAUTION: DO NOT APPLY HEAVY PRESSURE WHEN FILING AS THIS MAY BEND WORKPIECE 5. INSPECT PART #11 AND ROUTE TO MILLING MACHINE UPON COMPLETION OF PART #12
6. TURN 5/32" X 30° BEVEL ON PART #12	1. LOOSEN COLLET AND SLIDE WORKPIECE OUT NOTE: HOLD 1/2" EXTENDING OUT FROM COLLET 2. TURN 5/32" X 30° BEVEL AS PER STEP 5 3. INSPECT THREADS 4. LOOSEN COLLET AND REMOVE WORKPIECE
7. FACE TO LENGTH	1. INSERT WORKPIECE INTO COLLET NOTE: THREADED END WILL BE IN COLLET WITH WORKPIECE EXTENDED OUT 1/2" 2. FACE END

STEPS	KEY POINTS
	NOTE: HOLD 1 13/16" OVERALL LENGTH
	3. FILE 1/32" X 30° BEVEL AS PER STEP 5
	4. REMOVE FROM COLLET
	5. BURR AND INSPECT
	6. SECURE MACHINE AND TOOLS
	ROUTE PARTS #11 AND #12 TO HORIZONTAL MILLING MACHINE

SKETCHES: DRAWING #3-E: SURFACE GAGE

REFERENCES: REF. #3, PP. 135-184
REF. #4, PP. 217-282
REF. #5, PP. 141-182

IX-C-6(J)

JOB SHEET
ON
HORIZONTAL MILLING MACHINE

JOB: SURFACE GAGE

MATERIALS: PARTS #11 AND #12: PIVOT SCREWS "A" AND "B" AS MACHINED ON THE ENGINE LATHE

TOOLS AND EQUIPMENT: HORIZONTAL MILLING MACHINE, DIVIDING HEAD WITH UNIVERSAL CHUCK, ARBOR AND SPACING COLLARS, 1/32" SLITTING SAW, SHIM STOCK, [illegible]" RULE, AND MILL FILE

GENERAL INSTRUCTION: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 229-270; REF. #4, PP. 317-354; REF. #5, PP. 223-241. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE AND UPON COMPLETION OF THE TASKS

PROCEDURES AND/OR TASKS:

IX-A-1(TS)	CHECK HORIZONTAL MILL FOR PROPER OPERATING CONDITION
IX-C-1(TS)	SET UP DIVIDING HEAD
*IX-C-6(TS)	MILL 1/32" SLOTS IN PIVOT SCREWS "A" AND "B"

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS

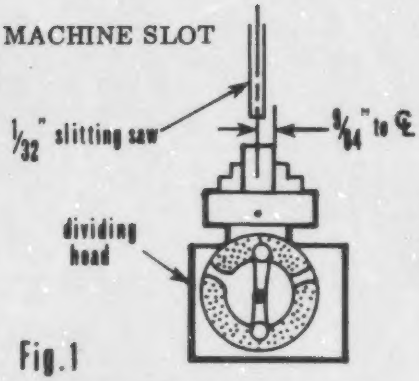
1. CHECK HORIZONTAL MILLING MACHINE FOR PROPER OPERATING CONDITION
2. DIVIDING HEAD SET UP AND PROPERLY ALIGNED
3. WORKPIECE AND TOOLING PROPERLY SET UP
4. ALL DIMENSIONS HELD TO SPECIFICATIONS AND TOLERANCE
5. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS

TASK SHEET

IX-C-6(TS)

TASK:	MILL 1/32" SLOT IN PIVOT SCREWS "A" AND "B"
JOB:	SURFACE GAGE
TRADE:	MACHINIST
TOOLS AND MATERIALS:	HORIZONTAL MILLING MACHINE, DIVIDING HEAD WITH UNIVERSAL CHUCK, ARBOR AND SPACING COLLARS, 1/32" SLITTING SAW, SHIM STOCK, 6" RULE, MILL FILE, AND PIVOT SCREWS "A" AND "B" AS MACHINED ON THE LATHE

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP MACHINE	1. SET UP SLITTING SAW NOTE: DO NOT CLIMB MILL 2. SET FEED AND SPEED
2. SET UP WORKPIECE NOTE: PART #12: PIVOT SCREW "A"	1. CHUCK WORKPIECE IN UNIVERSAL CHUCK ON DIVIDING HEAD CAUTION: PROTECT THREADS WITH SHIM STOCK 2. TIGHTEN CHUCK CAUTION: DO NOT TIGHTEN TOO TIGHT AND DAMAGE THREADS 3. ROTATE DIVIDING HEAD UNTIL CHUCK CENTER AND WORKPIECE ARE PERPENDICULAR TO TABLE NOTE: ROTATE HEAD 90°
3. MACHINE SLOT  Fig.1	1. POSITION WORKPIECE NOTE: CENTER WORKPIECE BENEATH SLITTING SAW. REFER TO FIGURE 1 2. MACHINE SLOT TO SIZE NOTE: HOLD 1/8" DEPTH 3. BURR EDGES 4. REMOVE FROM CHUCK AND INSPECT 5. HOLD PART "A" FOR ASSEMBLY UPON COMPLETION OF PART #11: PIVOT SCREW "B"
4. MACHINE SLOT NOTE: PART #11: PIVOT SCREW "B"	1. CHUCK WORKPIECE AS PER STEP #2 2. MILL SLOT TO SIZE NOTE: HOLD 1/8" DEPTH

STEPS	KEY POINTS
	CAUTION: TAKE SEVERAL LIGHT CUTS TO AVOID KICKING WORKPIECE OUT OF POSITION
	3. REMOVE WORKPIECE AND BURR
	4. INSPECT
	5. SECURE TOOLING AND MACHINE
	6. HOLD PARTS #11 AND #12 FOR ASSEMBLY

SKETCHES: DRAWING #3-E: SURFACE GAGE

REFERENCES: REF. #3, PP. 229-270
REF. #4, PP. 317-354
REF. #5, PP. 223-241

VII-C-6(J)

JOB SHEET
ON
ENGINE LATHE

JOB: SURFACE GAGE

MATERIALS: PART #16: ANGULAR WASHER - 3/4" X 1 3/16" C. R. ROUND
NOTE: 1" OF STOCK WILL BE USED ONLY FOR CHUCKING PURPOSES

TOOLS AND EQUIPMENT: ENGINE LATHE, COLLET ATTACHMENT, 3/4" COLLET, FACING TOOL, TURNING TOOL, DRILL CHUCK AND KEY, CENTERDRILL, 3/16" DRILL, 5/16" COUNTERBORE WITH 3/16" PILOT, CUT-OFF TOOL, 0-1" MICROMETER, 6" RULE, MILL FILE, AND DEPTH MICROMETER

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 135-184; REF. #4, PP. 217-282; REF. #5, PP. 141-182. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE AND UPON COMPLETION OF TASK
NOTE: UPON COMPLETION OF TURNING, DRILLING, AND COUNTERBORING OPERATION, ROUTE TO THE VERTICAL MILLING MACHINE TO MILL SLOT. REROUTE BACK TO THE LATHE FOR CUTTING OFF WASTE STOCK

PROCEDURES AND/OR TASK:

VII-A-1(TS)	CHECK ENGINE LATHE FOR PROPER OPERATING CONDITION
VII-C-2(TS)	SET UP COLLET ATTACHMENT
*VII-C-6(TS)	TURN, DRILL, AND COUNTERBORE ANGULAR WASHER
	ROUTE TO VERTICAL MILLING MACHINE

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS

1. CHECK OPERATING CONDITION OF LATHE
2. CORRECT SELECTION AND SETUP OF TOOLING AND WORKPIECE
3. ALL DIMENSIONS HELD TO SPECIFICATIONS AND TOLERANCE
4. OBSERVANCE OF ALL SAFETY PROCEDURES
5. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS

TASK SHEET VII-C-6(TS)

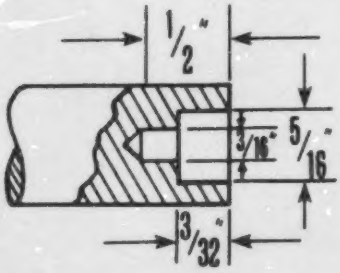
TASK: TURN, DRILL, AND COUNTERBORE ANGULAR WASHER

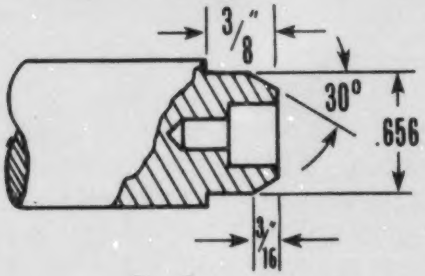
JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: ENGINE LATHE, COLLET ATTACHMENT, 3/4" COLLET, FACING TOOL, TURNING TOOL, DRILL CHUCK AND KEY, CENTERDRILL, 3/16" DRILL, 5/16" COUNTERBORE WITH 3/16" PILOT, CUT-OFF TOOL, 0-1" MICROMETER, DEPTH MICROMETER, 6" RULE, MILL FILE, AND 3/4" X 1 3/16" C. R. ROUND FOR PART #16: ANGULAR WASHER

TASKBREAKDOWN:

STEPS	KEY POINTS
1. SET UP WORKPIECE	1. INSTALL COLLET ATTACHMENT 2. INSTALL 3/4" COLLET 3. CHUCK WORKPIECE NOTE: LET WORKPIECE EXTEND OUT 1/2"
2. FACE AND CENTER-DRILL	1. SET UP FACING TOOL 2. FACE FOR CLEANUP ONLY 3. SET UP DRILL CHUCK AND CENTERDRILL 4. CENTERDRILL WORKPIECE FOR PILOT HOLE 5. REMOVE CENTERDRILL
3. DRILL AND COUNTER-BORE HOLE  Fig. 1	1. SET UP 3/16" DRILL NOTE: INSPECT FOR SIZE AND CONDITION 2. DRILL HOLE. SEE FIG. 1 NOTE: HOLD 1/2" DEPTH 3. REMOVE 3/16" DRILL 4. SET UP 5/16" COUNTERBORE WITH 3/16" PILOT 5. SET SPINDLE SPEED TO ABOUT 1/3 DRILLING SPEED 6. COUNTERBORE HOLE NOTE: HOLD 5/16" DIAMETER 3/32" DEEP
4. TURN DIAMETER	1. SET UP TURNING TOOL 2. TURN DIAMETER TO SIZE. SEE FIG. 2 NOTE: HOLD .656" DIAMETER 3/8" LENGTH

STEPS	KEY POINTS
 Fig. 2	3. TURN 30° BEVEL NOTE: HOLD 30° X 3/16" 4. BURR WORKPIECE 5. INSPECT 6. ROUTE TO VERTICAL MILLING MACHINE TO MILL SLOT NOTE: DO NOT CUT OFF EXCESS MATERIAL UNTIL COMPLETION OF MILLING OPERATION
5. CUT OFF WORKPIECE TO SIZE	1. CHUCK MATERIAL AS PER STEP #1 NOTE: LET WORKPIECE EXTEND OUT 1/2" 2. SET UP CUT OFF TOOL 3. CUT WORKPIECE OFF NOTE: HOLD 3/16" FINISH SIZE NOTE: BURR OR BREAK EDGE PRIOR TO COMPLETION OF CUTTING OFF 4. INSPECT AND BURR 5. SECURE ALL TOOLS AND EQUIPMENT 6. ROUTE TO ARBOR PRESS FOR BROACHING TASK NOTE: IF SLOT IS TO BE FILED RATHER THAN BROACHED, ROUTE TO THE BENCH AND USE A PATTERN FILE TO FILE SLOT

SKETCHES: DRAWING #3-F: SURFACE GAGE

REFERENCES:
REF. #3, PP. 135-184
REF. #4, PP. 217-282
REF. #5, PP. 141-182

IX-C-7(J)

JOB SHEET
ON
VERTICAL MILLING MACHINE

JOB: SURFACE GAGE

MATERIALS: PART #16: ANGULAR WASHER AS MACHINED IN PREVIOUS TASKS ON THE LATHE

TOOLS AND EQUIPMENT: VERTICAL MILLING MACHINE, DIVIDING HEAD WITH UNIVERSAL CHUCK, 3/16" END MILL, 3/16" END MILL HOLDER, 6" RULE, AND MILL FILE

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 229-270; REF. #4, PP. 317-354; REF. #5, PP. 223-241. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE AND UPON COMPLETION OF THE TASK

NOTE: UPON COMPLETION OF MILLING TASK, ROUTE WORKPIECE BACK TO ENGINE LATHE TO CUT OFF WORKPIECE TO SIZE

PROCEDURES AND/OR TASK:

IX-A-1(TS) CHECK VERTICAL MILLING MACHINE FOR PROPER OPERATING CONDITION

IX-C-1(TS) SET UP DIVIDING HEAD

*IX-C-7(TS) MILL 3/16" X 5/16" OBLONG SLOT

ROUTE TO ENGINE LATHE

NOTE: REFER TO VII-C-6(TS) FOR COMPLETION OF PART

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS

1. CHECK OPERATING CONDITION OF VERTICAL MILLING MACHINE
2. CHECK DIVIDING HEAD FOR PROPER SETUP AND ALIGNMENT
3. CORRECT SETUP OF WORKPIECE AND TOOLING
4. ALL DIMENSIONS HELD TO SPECIFICATIONS AND TOLERANCE
5. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS
6. OBSERVANCE OF ALL SAFETY REGULATIONS

TASK SHEET

IX-C-7(TS)

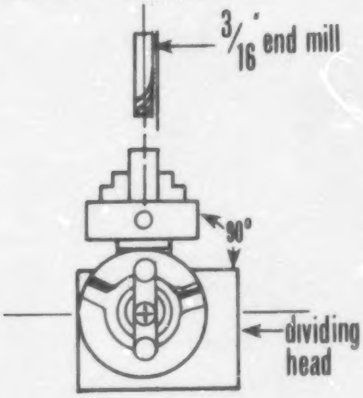
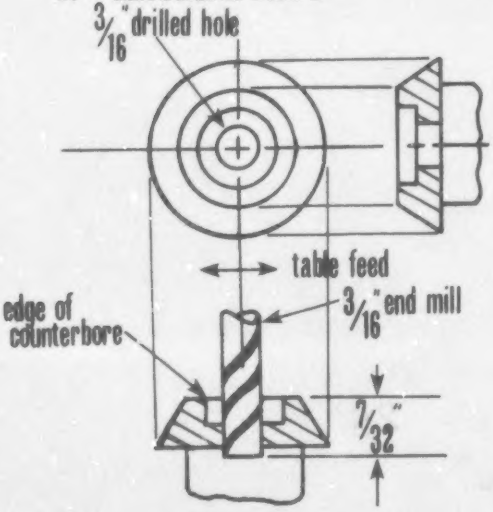
TASK: MILL 3/16" X 5/16" OBLONG SLOT

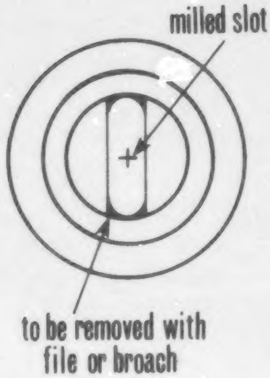
JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: VERTICAL MILLING MACHINE, DIVIDING HEAD WITH UNIVERSAL CHUCK, 3/16" END MILL, END MILL HOLDER, 6" RULE, DIAL INDICATOR, MILL FILE, AND PART #16: ANGULAR WASHER AS MACHINED IN PREVIOUS TASK

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP MACHINE	1. SET UP 3/16" END MILL HOLDER 2. MOUNT 3/16" END MILL 3. CHECK END MILL FOR RUNNING TRUE 4. SET SPINDLE SPEED
2. SET UP WORKPIECE  Fig. 1	1. CHUCK WORKPIECE IN UNIVERSAL CHUCK NOTE: CLAMP ON EXCESS MATERIAL NOTE: COUNTERBORED FACE WILL BE UPRIGHT 2. TIGHTEN CHUCK 3. ROTATE DIVIDING HEAD 90° NOTE: WORKPIECE WILL BE PERPENDICULAR TO TABLE. REFER TO FIG. 1 4. CHECK WORKPIECE ALIGNMENT NOTE: USE DIAL INDICATOR TO INSURE WORKPIECE IS PERPENDICULAR TO TABLE
3. MACHINE SLOT  3/16" drilled hole table feed 3/16" end mill edge of counterbore 7/32" Fig. 2	1. LOCATE END MILL WITH 3/16" DRILLED HOLE NOTE: LOWER END MILL UNTIL IT IS LOCATED IN 3/16" HOLE 2. RAISE SPINDLE 3. RAISE TABLE UNTIL END MILL IS SLIGHTLY MORE THAN 3/16" DEEP. APPROXIMATELY 7/32". REFER TO FIG. 2 NOTE: BE SURE THE SPINDLE IS TURNED ON

STEPS	KEY POINTS
 Fig. 3	4. MOVE LONGITUDINAL FEED UNTIL END MILL HAS MACHINED UP TO EDGE OF COUNTERBORE ON TWO SIDES. REFER TO FIG. 2 NOTE: THIS WILL LEAVE ONLY THE FOUR CORNERS TO BE BROACHED OR FILED, WHICHEVER METHOD IS USED. REFER TO FIG. 3 CAUTION: TO ATTEMPT TO BROACH THE SLOT WITHOUT MILLING SLOT FIRST WOULD RESULT IN BENDING THE 3/32" FLANGE ON THE BOTTOM OF THE WASHER 5. REMOVE WORKPIECE AND BURR 6. INSPECT 7. SECURE ALL TOOLING AND MACHINE 8. ROUTE WORKPIECE BACK TO THE LATHE TO CUT OFF WASTE MATERIAL

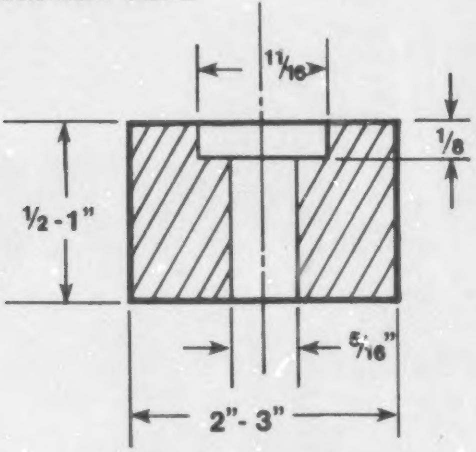
SKETCHES: DRAWING #3-F: SURFACE GAGE

REFERENCES:
REF. #3, PP. 229-270
REF. #4, PP. 317-354
REF. #5, PP. 223-241

VI-C-4(J)

JOB SHEET
ON
DRILL PRESS

JOB: SURFACE GAGE



FIXTURE FOR BROACH

MATERIALS:	3/4" X 2" X 3" PLATE NOTE: SCRAP PLATE CAN BE USED. SIZE OF MATERIAL IS NOT CRITICAL, BUT SHOULD BE 1/2" OR THICKER
TOOLS AND EQUIPMENT:	DRILL PRESS, DRILL PRESS VISE, DRILL CHUCK AND KEY, 5/16" DRILL, 11/16" COUNTERBORE WITH 5/16" PILOT, DEPTH MICROMETER, AND MILL FILE
GENERAL INSTRUCTIONS:	BEFORE BEGINNING THIS JOB READ REF. #3, PP. 95-120; REF. #4, PP. 177-211; REF. #5, PP. 115-138. CHECK WITH INSTRUCTOR BEFORE USING MACHINE AND UPON COMPLETION OF TASKS

PROCEDURES AND/OR TASK:	VI-A-1(TS)	CHECK DRILL PRESS FOR PROPER OPERATING CONDITION
	VI-A-1a(TS)	SET UP DRILL PRESS VISE AND WORKPIECE
	*VI-C-4(TS)	MACHINE SPECIAL BROACH FIXTURE ROUTE TO ARBOR PRESS

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASK

1. CHECK OPERATING CONDITION OF DRILL PRESS
2. CORRECT SETUP OF VISE AND WORKPIECE
3. CORRECT SELECTION AND INSPECTION OF TOOL
4. ALL DIMENSIONS HELD TO SPECIFICATIONS
5. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS

TASK SHEET VI-C-4(TS)

TASK: MACHINE SPECIAL BROACH FIXTURE

JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: DRILL PRESS, DRILL PRESS VISE, DRILL CHUCK AND KEY, 5/16" DRILL, 11/16" COUNTERBORE WITH 5/16" PILOT, DEPTH MICROMETER, AND MILL FILE

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP WORKPIECE	1. FASTEN DRILL VISE TO TABLE 2. BURR EDGES OF WORKPIECE NOTE: MATERIAL FOR BROACH FIXTURE CAN BE ANY SIZE SCRAP, 1/2" THICK OR GREATER 3. SET UP WORKPIECE ON PARALLELS NOTE: PARALLELS NOT REQUIRED ON MATERIAL OVER 1/2" THICK 4. LOCATE WORKPIECE IN CENTER OF VISE
2. DRILL 5/16" HOLE	1. SET UP DRILL NOTE: INSPECT FOR SIZE AND CONDITION 2. DRILL HOLE THROUGH NOTE: LOCATION OF HOLE IS NOT IMPORTANT 3. REMOVE DRILL
3. COUNTERBORE 11/16" HOLE	1. SET UP COUNTERBORE NOTE: INSPECT FOR SIZE AND CONDITION 2. ALIGN PILOT WITH 5/16" DRILLED HOLE NOTE: UNLESS SETUP WAS MOVED, THERE SHOULD BE NO CHANGE IN ALIGNMENT 3. COUNTERBORE HOLE NOTE: HOLD 1/8" DEEP 4. BURR WORKPIECE 5. INSPECT 6. SECURE TOOLS AND MACHINE

STEPS	KEY POINTS
	7. ROUTE TO ARBOR PRESS

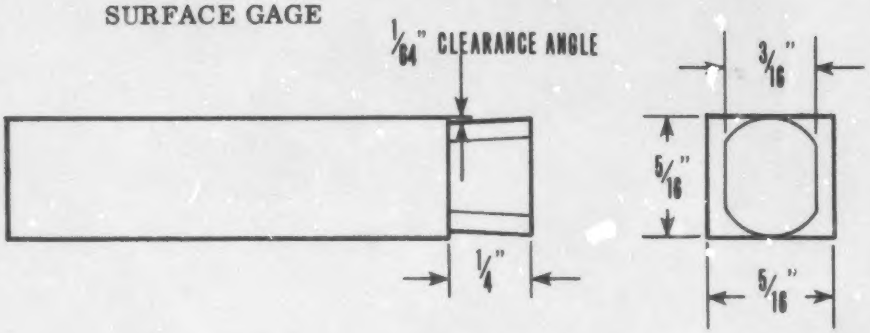
SKETCHES: SEE DRAWING WITH JOB SHEET

REFERENCES:
REF. #3, PP. 95-120
REF. #4, PP. 177-211
REF. #5, PP. 115-138

X-B-4(J)

JOB SHEET
ON
GRINDER

JOB: SURFACE GAGE



SPECIAL BROACH

MATERIALS:	MADE FROM 5/16" X 5/16" H. S. S. LATHE TOOL	
TOOLS AND EQUIPMENT:	PEDESTAL GRINDER, 5/32" RADIUS GAGE, 0-1" MICROMETER, 6" RULE, AND HONE	
GENERAL INSTRUCTIONS:	BEFORE BEGINNING THIS JOB, STUDY THE ABOVE DRAWING, READ REF. #3, PP. 121-125; REF. #4, PP. 143-147	
PROCEDURES AND/OR TASK:	X-B-4(TS)	CHECK GRINDER FOR PROPER OPERATING CONDITION
	X-B-4a(TS)	DRESS AND TRUE GRINDING WHEEL
	*X-B-4b(TS)	GRIND SPECIAL BROACH
		ROUTE TO ARBOR PRESS
CHECK POINTS:	STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASK	

1. CHECK OPERATING CONDITION OF GRINDER
2. GRINDING WHEEL PROPERLY DRESSED
3. OBSERVANCE OF ALL SAFETY REGULATIONS

TASK SHEET

X-B-4b(TS)

TASK:	GRIND SPECIAL BROACH
JOB:	SURFACE GAGE
TRADE:	MACHINIST
TOOLS AND MATERIALS:	5/16" H.S.S. LATHE TOOL, BENCH OR PEDESTAL GRINDER, 0-1" MICROMETER, 6" RULE, HONE, AND 5/32" RADIUS GAGE

TASK BREAKDOWN:

STEPS	KEY POINTS
1. DRESS GRINDING WHEEL	1. FACE WHEEL 2. TRUE WHEEL NOTE: USE DIAMOND POINT WHEEL DRESSER
2. GRIND BROACH	1. GRIND 1/16" OFF ON TWO OPPOSITE SIDES. REFER TO DRAWING NOTE: HOLD 3/16" X 5/16" X 1/4" LONG NOTE: CHECK SIDES FOR SQUARENESS WITH EACH OTHER NOTE: GIVE 1/64" CLEARANCE ANGLE TO BROACH ON SIDES 2. GRIND RADIUS ON THE OTHER TWO SIDES NOTE: ROUNDED SURFACES SHOULD BLEND INTO THE STRAIGHT SURFACES OF THE TOOL NOTE: CHECK WITH RADIUS GAGE 3. GRIND CHAMFER ON HEAD OF TOOL NOTE: THIS IS FOR SAFETY PURPOSES 4. BURR TOOL WITH HONE NOTE: SAME PROCEDURE AS HONING A TOOL 5. INSPECT NOTE: CHECK WITH RADIUS GAGE ROUTE TO ARBOR PRESS

SKETCHES:	SEE DRAWING ATTACHED TO JOB SHEET
REFERENCES:	REF. #3, PP. 121-125 REF. #4, PP. 143-147

IV-C-6(J)

JOB SHEET
ON
BENCH

JOB:	SURFACE GAGE
MATERIALS:	PART #16: ANGULAR WASHER AS MACHINED IN PREVIOUS TASKS
TOOLS AND EQUIPMENT:	ARBOR PRESS, SPECIAL BROACH, BROACH FIXTURE, AND PATTERN FILE
GENERAL INSTRUCTIONS:	BEFORE BEGINNING THIS JOB READ REF. #3, PP. 223-225; REF. #4, PP. 25-29; REF. #5, PP. 76-77. CHECK WITH INSTRUCTOR BEFORE BROACHING WORKPIECE AND UPON COMPLETION OF TASKS

PROCEDURE AND/OR	IV-C-6 (TS)	SET UP ARBOR PRESS
	*IV-C-6a (TS)	BROACH SLOT
		HOLD FOR ASSEMBLY

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASK

1. PROPER SETUP OF ARBOR PRESS AND BROACH
2. PROPER INSTALLATION OF WORKPIECE AND FIXTURE
3. OBSERVANCE OF ALL SAFETY REGULATIONS

TASK SHEET

IV-C-6a (TS)

TASK: BROACH SLOT

JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: ARBOR PRESS, SPECIAL BROACHING FIXTURE, SPECIAL BROACH, PATTERN FILE, AND PART #16: ANGULAR WASHER AS PREVIOUSLY MACHINED

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP WORKPIECE	1. PLACE FIXTURE ON ARBOR PRESS TABLE 2. PLACE WORKPIECE IN FIXTURE NOTE: LARGE DIAMETER FACE DOWN 3. PLACE BROACH ON WORKPIECE NOTE: CHECK TO SEE THAT BROACH IS PLACED IN WORKPIECE IN A VERTICAL POSITION
2. BROACH SLOT	1. LUBRICATE BOTH WORKPIECE AND BROACH 2. PRESS BROACH THROUGH THE WORKPIECE NOTE: APPLY FIRM CONSTANT PRESSURE TO THE ARBOR PRESS 3. REMOVE BROACH 4. REMOVE WORKPIECE FROM FIXTURE 5. BURR EDGES WITH PATTERN FILE 6. SMOOTH RADIUS WITH FILE HOLD FOR ASSEMBLY

SKETCHES: DRAWING #3-F: SURFACE GAGE

REFERENCES:
REF. #3, PP. 223-225
REF. #4, PP. 25-29
REF. #5, PP. 76-77

JOB SHEET
ON
ENGINE LATHE

JOB: SURFACE GAGE

MATERIALS: PART #19: ADJUSTING SCREW - 5/8" X 2" C. R. ROUND

NOTE: 1 3/16" OF MATERIAL WILL BE FOR CHUCKING PURPOSE ONLY

TOOLS AND EQUIPMENT: ENGINE LATHE, INDEPENDENT CHUCK, DIAL INDICATOR, FACING TOOL, DRILL CHUCK, #1 CENTERDRILL, R.H. TURNING TOOL WITH 1/16"R, KNURLING TOOL, 60° THREADING TOOL, CENTER GAGE, SCREW PITCH GAGE, CUT-OFF TOOL, R.H. ROUGH TURNING TOOL, 0-1" MICROMETER, 6" RULE, LIVE CENTER, AND MILL FILE

NOTE: 6-32 N.C. DIE AND DIE STOCK MAY BE USED AS AN ALTERNATE FOR CUTTING THREADS WITH THREADING TOOL

GENERAL INSTRUCTIONS: BEFORE BEGINNING JOB READ REF. #3, PP. 135-184; REF. #4, PP. 217-282; REF. #5, PP. 141-182. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE, AND PROCEDURE TO FOLLOW IN CUTTING THREADS ON A SMALL DIAMETER. IT IS RECOMMENDED THAT THE WORKPIECE REMAIN CHUCKED IN THE LATHE AND THREADED USING A 6-32 N.C. DIE. THIS WILL BE LEFT UP TO THE DISCRETION OF THE INSTRUCTOR

PROCEDURES AND/OR TASK:

VII-A-1(TS)	CHECK ENGINE LATHE FOR PROPER OPERATING CONDITION
*VII-C-7(TS)	MACHINE ADJUSTING SCREW - PART #19 HOLD FOR ASSEMBLY

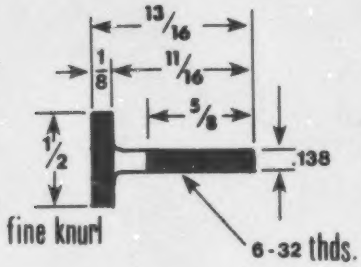
CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS

1. CHECK OPERATING CONDITION OF ENGINE LATHE
2. CORRECT SETUP OF TOOLING AND WORKPIECE
3. CORRECT METHOD TO BE USED FOR THREADING
4. ALL DIMENSIONS HELD TO SPECIFICATIONS AND TOLERANCES
5. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS

TASK:	MACHINE ADJUSTING SCREW - PART #19
JOB:	SURFACE GAGE
TRADE:	MACHINIST
TOOLS AND MATERIALS:	ENGINE LATHE, INDEPENDENT CHUCK, LIVE CENTER, 6-32 N. C. DIE, DIE HANDLE, 0-1" MICROMETER, 6" RULE, KNURLING TOOL, THREADING TOOL, CENTER GAGE, SCREW PITCH GAGE, DIAL INDICATOR, CUT-OFF TOOL, MILL FILE, AND PART #19: ADJUSTING SCREW - 5/8" - 2" C. R. ROUND

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP WORKPIECE	1. SET UP INDEPENDENT CHUCK 2. MOUNT WORKPIECE IN CHUCK NOTE: 1 1/4" OF WORKPIECE EXTENDED OUT FROM END OF CHUCK JAWS 3. TRUE WORKPIECE NOTE: USE DIAL INDICATOR
2. FACE AND CENTERDRILL WORKPIECE	1. SET UP FACING TOOL 2. FACE WORKPIECE FOR CLEANUP ONLY 3. SET UP DRILL CHUCK AND CENTERDRILL 4. CENTERDRILL WORKPIECE NOTE: CENTERDRILL SMALL HOLE 5. REMOVE DRILL CHUCK AND CENTERDRILL 6. PLACE LIVE CENTER IN TAILSTOCK 7. SLIDE LIVE CENTER UP TO SUPPORT WORKPIECE
3. TURN LARGE DIAMETER	1. SET UP ROUGH TURNING TOOL 2. TURN WORKPIECE TO .500" DIAMETER NOTE: HOLD 1 1/8" LENGTH 3. REMOVE TURNING TOOL
4. KNURL WORKPIECE	1. SET UP KNURLING TOOL NOTE: USE FINE PITCH KNURL 2. SET SPINDLE SPEED AND FEED 3. KNURL WORKPIECE NOTE: FULL KNURL TO COVER SCREW HEAD AREA
5. TURN SMALL DIAMETER	1. SET UP ROUGH TURNING TOOL

STEPS	KEY POINTS
 Fig. 1	2. ROUGH TURN WORKPIECE TO .200" NOTE: HOLD 11/16" LENGTH CAUTION: TAKE LIGHT CUTS TO PREVENT BENDING OF WORKPIECE 3. REMOVE ROUGH TURNING TOOL 4. SET UP FINISH TURNING TOOL WITH 1/16" RADIUS 5. FINISH TURN TO .138" DIAMETER NOTE: HOLD 11/16" LENGTH WITH 1/16"R AS SPECIFIED NOTE: REFER TO FIGURE 1 CAUTION: DO NOT REMOVE ALL OF THE MATERIAL WITH ONE CUT. TAKE LIGHT CUTS ON DIAMETER THIS SMALL 6. REMOVE TURNING TOOL
6. THREAD WORKPIECE	NOTE: IT IS RECOMMENDED THAT THE 6-32 N.C. DIE BE USED TO CUT THREADS. CHECK WITH INSTRUCTOR FOR PROCEDURE TO BE USED
7. CUT OFF WORKPIECE	1. SET UP CUT-OFF TOOL 2. CUT OFF WORKPIECE NOTE: HOLD 1/8" HEAD SIZE WITH TOTAL LENGTH 13/16" AS SPECIFIED NOTE: BREAK ALL EDGES WITH FILE PRIOR TO CUT-OFF 3. REMOVE EXCESS MATERIAL AND DISPOSE OF IT 4. SECURE MACHINE AND ALL TOOLS PROPERLY 5. INSPECT WORKPIECE HOLD FOR ASSEMBLY

SKETCHES: DRAWING #3-F: SURFACE GAGE

REFERENCES:
REF. #3, PP. 135-184
REF. #4, PP. 217-282
REF. #5, PP. 141-182

VII-C-8(J)

JOB SHEET
ON
ENGINE LATHE

JOB:	SURFACE GAGE	
MATERIALS:	PART #20: PINS - 4 REQUIRED 3/16 X 1 1/8" EACH - C. R. ROUND	
TOOLS AND EQUIPMENT:	ENGINE LATHE, COLLET ATTACHMENT, 3/16" COLLET, FACING TOOL, 6" RULE, AND MILL FILE	
GENERAL INSTRUCTIONS:	BEFORE BEGINNING JOB READ REF. #3, PP. 135-184; REF. #4, PP. 217-282; REF. #5, PP. 141-182. CHECK WITH THE INSTRUCTOR BEFORE OPERATING MACHINE	
PROCEDURES AND/OR TASK:	VII-A-1(TS)	CHECK ENGINE LATHE FOR PROPER OPERATING CONDITION
	*VII-C-8(TS)	FACE PINS TO LENGTH
		ROUTE TO HORIZONTAL MILLING MACHINE
CHECK POINTS:	STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS	

1. CHECK OPERATING CONDITION OF LATHE
2. CORRECT SETUP OF TOOLING AND WORKPIECE
3. ALL DIMENSIONS HOLD TO SPECIFICATIONS
4. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS
5. OBSERVANCE OF ALL SAFETY REGULATIONS

TASK SHEET

VII-C-8(TS)

TASK:	FACE PINS TO LENGTH
JOB:	SURFACE GAGE
TRADE:	MACHINIST
TOOLS AND MATERIALS:	ENGINE LATHE, COLLET ATTACHMENT, 3/16" COLLET, 6" RULE, FACING TOOL, MILL FILE, AND PART #20: PIN-4 PCS. 3/16" X 1 1/8" C.R. ROUND

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP WORKPIECE	1. INSTALL 3/16" COLLET
	2. INSERT WORKPIECE INTO COLLET NOTE: 1/4" EXTENDING OUT FROM COLLET
	3. SET SPINDLE SPEED AND FEED
2. FACE WORKPIECE TO LENGTH	1. SET UP FACING TOOL
	2. FACE END FOR CLEANUP ONLY NOTE: BREAK EDGES WITH FILE
	3. REMOVE WORKPIECE AND REVERSE ENDS NOTE: 1/4" EXTENDING OUT FROM COLLET
	4. FACE OTHER END NOTE: HOLD 1 1/16" LENGTH AS SPECIFIED
	5. BREAK EDGE WITH FILE
	6. REMOVE WORKPIECE FROM COLLET
	7. SECURE TOOLS AND MACHINE NOTE: COMPLETE THE TASK ON ALL FOUR PINS BEFORE SECURING MACHINE
	ROUTE TO HORIZONTAL MILLING MACHINE

SKETCHES: DRAWING #3-F: SURFACE GAGE

REFERENCES:
REF. #3, PP. 135-184
REF. #4, PP. 217-282
REF. #5, PP. 141-182

IX-C-8(J)

JOB SHEET
ON
HORIZONTAL MILLING MACHINE

JOB: SURFACE GAGE

MATERIALS: PART #20: PINS - 4 REQUIRED AS MACHINED IN PREVIOUS TASK

TOOLS AND EQUIPMENT: HORIZONTAL MILLING MACHINE, DIVIDING HEAD WITH UNIVERSAL CHUCK, ARBOR, SPACING COLLARS, 1/32" SLITTING SAW, 6" RULE, AND MILL FILE

GENERAL INSTRUCTIONS: BEFORE BEGINNING JOB READ REF. #3, PP. 229-270; REF. #4, PP. 317-354: REF. #5, PP. 223-241. CHECK WITH THE INSTRUCTOR PRIOR TO USING MACHINE

PROCEDURES AND/OR TASKS:
IX-A-1(TS) CHECK HORIZONTAL MILL FOR PROPER OPERATING CONDITION
IX-A-1a(TS) SET UP DIVIDING HEAD
*IX-C-8(TS) MILL SLOTS

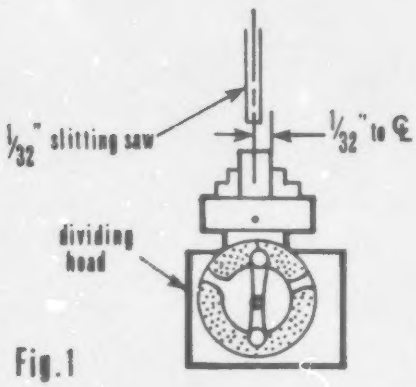
CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASK

1. CHECK OPERATING CONDITION OF MILLING MACHINE
2. CORRECT SETUP OF TOOLING AND WORKPIECE
3. ALL DIMENSIONS HELD TO SPECIFICATIONS
4. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS
5. OBSERVANCE OF ALL SAFETY REGULATIONS

TASK SHEET IX-C-8(TS)

TASK:	MILL SLOTS
JOB:	SURFACE GAGE
TRADE:	MACHINIST
TOOLS AND MATERIALS:	HORIZONTAL MILLING MACHINE, DIVIDING HEAD WITH UNIVERSAL CHUCK, ARBOR, SPACING COLLARS, 1/32" SLITTING SAW, 6" RULE, MILL FILE, DIAL INDICATOR, AND PART #20: 4 PINS AS MACHINED ON THE LATHE

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP WORKPIECE	1. MOUNT WORKPIECE IN UNIVERSAL CHUCK NOTE: 9/16" OF WORKPIECE EXTENDING OUT 2. ROTATE DIVIDING HEAD 90° NOTE: REFER TO FIGURE 1 NOTE: WORKPIECE WILL BE PERPENDICULAR TO TABLE 3. CHECK WORKPIECE FOR ALIGNMENT
2. MILL 1/32" SLOT  Fig.1	1. CENTER SLITTING SAW OVER WORKPIECE NOTE: REFER TO FIGURE 1 2. SET SPINDLE SPEED AND TABLE FEED 3. MILL SLOT TO 17/32" DEPTH NOTE: TAKE LIGHT CUTS TO AVOID BENDING WORKPIECE 4. REMOVE WORKPIECE AND MILL THE OTHER THREE PARTS AS IN PREVIOUS STEPS 5. BURR EDGES ON ALL FOUR PINS 6. INSPECT 7. SECURE TOOLS AND MACHINE HOLD FOR ASSEMBLY

SKETCHES:	DRAWING #3-F: SURFACE GAGE
REFERENCES:	REF. #3, PP. 229-270 REF. #4, PP. 317-354 REF. #5, PP. 223-241

VII-C-9(J)

JOB SHEET
ON
ENGINE LATHE

JOB:	SURFACE GAGE
MATERIALS:	PARTS #22 AND #18: PRESSURE NUTS A AND B - 1 1/8" X 2" C.R. ROUND NOTE: THIS WILL PROVIDE SUFFICIENT MATERIAL FOR BOTH PARTS
TOOLS AND EQUIPMENT:	ENGINE LATHE, INDEPENDENT CHUCK, DIAL INDICATOR, FACING TOOL, R.H. ROUGH TURNING TOOL, R. H. FINISH TURNING TOOL WITH 1/16" RADIUS, KNURLING TOOL, DRILL CHUCK, CENTERDRILL, #36 DRILL, 9/32" DRILL, 0-1" MICROMETER, 6" RULE, LIVE CENTER, 6-32 N.C. TAPER TAP, 6-32 N.C. BOTTOM OR PLUG TAP, THREAD CUTTING OIL, CUT-OFF TOOL, AND MILL FILE
GENERAL INSTRUCTIONS:	BEFORE BEGINNING THIS JOB READ REF. #3, PP. 135-184; REF. #4, PP. 217-282; REF. #5, PP. 141-182. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE AND UPON COMPLETION OF THE TASK
PROCEDURES AND/OR	VII-A-1(TS) CHECK ENGINE LATHE FOR PROPER OPERATING CONDITION *VII-C-9(TS) MACHINE PRESSURE NUTS A AND B
CHECK POINTS:	STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS 1. CHECK THE OPERATING CONDITION OF THE LATHE 2. CORRECT SETUP OF TOOLING AND WORKPIECE 3. ALL DIMENSIONS HELD TO SPECIFICATIONS AND TOLERANCES 4. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS 5. OBSERVATION OF ALL SAFETY PROCEDURES

TASK SHEET VII-C-9(TS)

TASK: MACHINE PRESSURE NUTS A AND B

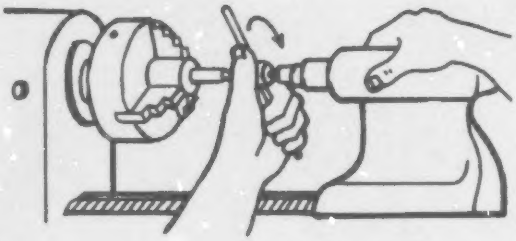
JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: ENGINE LATHE, INDEPENDENT CHUCK, DIAL INDICATOR, FACING TOOL, R.H. ROUGH TURNING TOOL, R.H. FINISH TURNING TOOL WITH 1/16"^{R}, KNURLING TOOL, DRILL CHUCK, CENTER DRILL, #36 DRILL, 9/32" DRILL, 0-1" MICROMETER, 1"-2" MICROMETER, 6" RULE, LIVE CENTER, 6-32 N.C. TAPER TAP, 6-32 N.C. PLUG OR BOTTOM TAP, DIE STOCK, THREAD CUTTING OIL, CUT-OFF TOOL, MILL FILE, AND 1 PIECE 1 1/8" X 2" C.R. ROUND FOR PARTS #22 AND #18: PRESSURE NUT A AND B

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP WORKPIECE	1. INSTALL WORKPIECE IN INDEPENDENT CHUCK NOTE: EXTEND WORKPIECE OUT 1 1/2" FROM CHUCK JAWS 2. TRUE WORKPIECE NOTE: INDICATE WITH DIAL INDICATOR
2. FACE AND CENTERDRILL	1. SET UP DRILL CHUCK AND CENTERDRILL 2. CENTERDRILL HOLE NOTE: THE FIRST PART TO BE MACHINED IS PART #22 3. REMOVE DRILL CHUCK 4. SET UP LIVE CENTER NOTE: MOVE LIVE CENTER UP TO SUPPORT WORKPIECE
3. TURN 3/4" DIAMETER	1. SET UP ROUGH TURNING TOOL 2. TURN TO SPECIFIED DIAMETER NOTE: HOLD 1" DIAMETER 3/4" LONG
4. KNURL WORKPIECE	1. SET UP KNURLING TOOL NOTE: KNURLS PLACED ON CENTER WITH WORKPIECE 2. KNURL WORKPIECE NOTE: KNURL TO SPECIFIED LENGTH
5. TURN 7/16" DIAMETER	1. SET UP ROUGH TURNING TOOL

STEPS	KEY POINTS
	2. TURN DIAMETER TO ROUGH SIZE NOTE: HOLD .500" DIAMETER 5/16" LENGTH
	3. REPLACE ROUGH TURNING TOOL WITH 1/16"^{R} FINISH TURNING TOOL
	4. TURN .437" DIAMETER X 5/16" LENGTH NOTE: HOLD 1/16" RADIUS
6. DRILL AND TAP HOLE	1. SET UP DRILL CHUCK WITH #36 DRILL
	2. DRILL HOLE NOTE: HOLD 3/4" DEEP
	3. REMOVE #36 DRILL
	4. INSTALL 9/32" DRILL
	5. COUNTERDRILL HOLE NOTE: HOLD 9/32" DIAMETER X 1/4" DEEP
7. TAP HOLE 6-32 N.C.	1. SET UP TAP IN WORKPIECE NOTE: USE TAPER TAP
	2. SET UP TAP WRENCH ON TAP
	3. SLIDE LIVE CENTER UP TO TAP NOTE: CENTER WILL SUPPORT TAP
	4. PUT MACHINE IN BACK GEAR IF BELT DRIVEN NOTE: ON GEAR HEAD LATHE USE BRAKE AND/OR SET IN SLOW GEAR RANGE TO PREVENT CHUCK FROM TURNING
	5. TURN TAP SLOWLY NOTE: USE SAME PROCEDURE AS IN TAPPING HOLE BY HAND ON THE BENCH CAUTION: DO NOT FORCE TAP. KEEP TAP LUBRICATED NOTE: BREAK CHIPS CONTINUOUSLY TO PREVENT BREAKING TAP
	6. TAP TO BOTTOM CAUTION: DO NOT JAM TAP
	7. REPLACE TAPER TAP WITH BOTTOM TAP
	8. THREAD TAP ALL THE WAY IN TO CUT FULL THREADS
	9. REMOVE TAP AND CLEAN OUT HOLE
	10. REMOVE TAP WRENCH AND TAILSTOCK
	11. INSPECT THREADS

STEPS	KEY POINTS
8. CUT OFF TO LENGTH	1. SET UP CUT-OFF TOOL 2. CUT WORKPIECE OFF NOTE: HOLD 3/16" HEAD THICKNESS WITH 1/2" OVERALL LENGTH AS SPECIFIED NOTE: BREAK EDGES WITH A FILE PRIOR TO CUTTING WORKPIECE COMPLETELY THROUGH 3. INSPECT 4. HOLD PART #22 FOR ASSEMBLY
9. MACHINE PART #18 NOTE: FOLLOW SAME PROCEDURE AS FOR PART #22	1. FACE END FOR CLEANUP NOTE: DO NOT REMOVE CENTER HOLE IN THE END 2. TURN DIAMETER TO 3/4" X 5/8" LENGTH 3. KNURL HEAD AS PER STEP #4 4. TURN .437" DIAMETER X 3/16" LENGTH NOTE: FINISH TURN WITH 1/16" RADIUS TOOL AS PER STEP #5 5. DRILL AND TAP 6-32 N.C. THREAD NOTE: TAP HOLE TO 1/2" DEPTH AS IN STEP #7 6. CUT WORKPIECE TO LENGTH AS PER STEP #8 NOTE: HOLD 3/16" HEAD THICKNESS WITH 3/8" OVERALL LENGTH AS SPECIFIED NOTE: BREAK EDGES WITH FILE PRIOR TO CUTTING WORKPIECE COMPLETELY THROUGH 7. INSPECT 8. REMOVE EXCESS MATERIAL AND DISPOSE OF 9. SECURE MACHINE AND ALL TOOLS HOLD FOR ASSEMBLY

SKETCHES: DRAWING #3-G: SURFACE GAGE

REFERENCES: REF. #3, PP. 135-184
REF. #4, PP. 217-282
REF. #5, PP. 141-182

VII-C-10(J)

JOB SHEET
ON
ENGINE LATHE

JOB: SURFACE GAGE

MATERIALS: PARTS #6, #9 , #15: WASHER - 7/16" X 1 1/2" C. R. ROUND THIS WILL ALLOW FOR EXCESS MATERIAL FOR CHUCKING

TOOLS AND EQUIPMENT: ENGINE LATHE, INDEPENDENT CHUCK, DIAL INDICATOR, FACING TOOL, DRILL CHUCK, 9/64" DRILL, 13/64" DRILL, 6" RULE, CUT-OFF TOOL, AND MILL FILE

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 135-184: REF. #4, PP. 217-282; REF. #5, PP. 141-182

DUE TO THE COMPLEXITY IN SETTING UP TO BROACH THE OBLONG HOLE IN PART #6, THE INSTRUCTOR MAY AT HIS DISCRETION CHOOSE TO FILE THE HOLE WITH A PATTERN FILE. FOR THE PURPOSE OF USING PRECISION METHODS OF MACHINING, THE TASK IS WRITTEN TO BE PERFORMED USING THE VERTICAL MILL AND BROACHING THE HOLE. A SPECIAL JOB SHEET AND TASK SHEET WILL BE WRITTEN FOR CONSTRUCTION OF THE SPECIAL BROACH AND BROACH FIXTURE. CHECK WITH INSTRUCTOR AS TO PROCEDURE TO FOLLOW BEFORE OPERATING MACHINES AND UPON COMPLETION OF THE LATHE OPERATION

PROCEDURES AND/OR TASKS:

VII-A-1(TS)	CHECK ENGINE LATHE FOR PROPER OPERATING CONDITION
*VII-C-10(TS)	MACHINE WASHERS "A"-"B"-"C" PARTS #6, #9, #15

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS

1. CHECK OPERATING CONDITION OF THE LATHE
2. CHECK MACHINE FOR PROPER SELECTION AND SETUP OF TOOLING
3. CHECK FOR PROPER SETUP OF WORKPIECE
4. ALL DIMENSIONS HELD TO SPECIFICATIONS
5. OBSERVANCE OF ALL SAFETY REGULATIONS
6. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLING, EQUIPMENT, SUPPLIES, AND STANDARDS

TASK SHEET VII-C-10(TS)

TASK: MACHINE WASHERS "A", "B", AND "C"

JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: ENGINE LATHE, INDEPENDENT CHUCK, DIAL INDICATOR, FACING TOOL, DRILL CHUCK, #1 CENTERDRILL, 9/64" DRILL, 13/64" DRILL, 6" RULE, CUT-OFF TOOL, MILL FILE, AND MATERIAL FOR PARTS #6, #9, AND #15: WASHERS "A"-"B"-"C"-7/16" X 1 1/2" C. R. ROUND

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP WORKPIECE	1. CHUCK WORKPIECE IN INDEPENDENT CHUCK NOTE: WORKPIECE WILL EXTEND OUT 3/4" FROM CHUCK JAW 2. TRUE WORKPIECE WITH DIAL INDICATOR NOTE: WORKPIECE MUST BE EXACTLY TRUE, AS THE MATERIAL IS THE FINISHED DIAMETER OF THE PARTS
2. FACE AND DRILL 9/64" HOLE	1. SET UP AND FACE END FOR CLEANUP ONLY 2. SET UP DRILL CHUCK AND CENTERDRILL 3. CENTERDRILL HOLE NOTE: CENTERDRILL FOR PILOT HOLE ONLY. DO NOT COUNTERSINK 4. SET UP 9/64" DRILL 5. DRILL HOLE 9/64" DIAMETER X 3/4" DEEP NOTE: THIS WILL PERMIT MATERIAL ALLOWANCE FOR ALL THREE PARTS, CUTTING EACH PART OFF, AND FACING END FOR CLEANUP ONLY
3. CUT-OFF WASHER "B"	1. SET UP CUT-OFF TOOL NOTE: INSPECT CUT-OFF TOOL FOR PROPERLY GROUND CUTTING EDGE CAUTION: BE SURE TOOL IS SET PERPENDICULAR WITH WORKPIECE AND CONTAINS SUFFICIENT CLEARANCE ON TOOL TO AVOID BENDING THE THIN WASHER DURING CUT-OFF OPERATION

STEPS	KEY POINTS
	2. CUT OFF PART #9 - WASHER "B" NOTE: HOLD 1/32" LENGTH NOTE: BURR EDGES PRIOR TO CUTTING COMPLETELY OFF 3. INSPECT 4. HOLD FOR ASSEMBLY
4. CUT OFF WASHER "C"	1. BURR OUTSIDE EDGE OF WORKPIECE 2. INSPECT FACE NOTE: SHOULD CUT-OFF TOOL NOT CUT PROPERLY THE END FACE WILL NOT BE SMOOTH, THEREFORE REQUIRING IT TO BE REFACED 3. POSITION CUT-OFF TOOL NOTE: HOLD 1/16" WASHER THICKNESS AS SPECIFIED 4. CUT OFF PART #15 - WASHER "C" NOTE: BURR AND INSPECT AS IN PREVIOUS STEP WITH WASHER "B" NOTE: HOLD FOR ASSEMBLY
5. DRILL 13/64" HOLE NOTE: THIS WILL BE IN PART #6 - WASHER "A"	1. SET UP 13/64" DRILL IN DRILL CHUCK 2. DRILL HOLE TO DEPTH NOTE: HOLD 1/4" DEPTH 3. REMOVE WORKPIECE FROM CHUCK 4. ROUTE TO VERTICAL MILLING MACHINE TO MILL SLOT, TASK IX-C-9(TS) NOTE: DO NOT CUT OFF EXCESS MATERIAL UNTIL COMPLETION OF MILLING OPERATION NOTE: REROUTE BACK TO ENGINE LATHE FOR CUT OFF OPERATION UPON COMPLETION OF MILLING SLOT
6. CUT OFF WORKPIECE TO SIZE	1. CHUCK MATERIAL AS PER STEP #1 2. SET UP CUT-OFF TOOL 3. CUT WORKPIECE OFF NOTE: HOLD 1/16" FINISHED SIZE AS SPECIFIED NOTE: BURR OR BREAK EDGE PRIOR TO CUTTING OFF 4. INSPECT AND BURR 5. SECURE ALL TOOLS AND EQUIPMENT 6. ROUTE TO ARBOR PRESS FOR BROACHING TASK

STEPS	KEY POINTS
	NOTE: IF SLOT IS TO BE FILED RATHER THAN BROACHED, ROUTE TO THE BENCH AND FILE SLOT WITH PATTERN FILE

SKETCHES: DRAWING #3-H: SURFACE GAGE

REFERENCES: REF. #3, PP. 135-184
REF. #4, PP. 217-282
REF. #5, PP. 141-182

JOB SHEET
ON
VERTICAL MILLING MACHINE

JOB: SURFACE GAGE

MATERIALS: PART #6: WASHER "A" AS MACHINED IN PREVIOUS TASKS ON THE LATHE

TOOLS AND EQUIPMENT: VERTICAL MILLING MACHINE, DIVIDING HEAD WITH UNIVERSAL CHUCK, 3/16" END MILL, END MILL HOLDER, 6" RULE, AND MILL FILE

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 229-270; REF. #4, PP. 317-354; REF. #5, PP. 223-241. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE AND UPON COMPLETION OF THE TASK

NOTE: UPON COMPLETION OF MILLING TASK, ROUTE WORKPIECE BACK TO THE ENGINE LATHE TO CUT OFF WORKPIECE TO SIZE

PROCEDURES AND/OR TASKS:

IX-A-1(TS) CHECK VERTICAL MILLING MACHINE FOR PROPER OPERATING CONDITION
IX-C-1(TS) SET UP DIVIDING HEAD
IX-C-9(TS) MILL 13/64" X 17/64" OBLONG SLOT
ROUTE TO ENGINE LATHE
NOTE: REFER BACK TO VII-C-10(TS) FOR COMPLETION OF PART

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS

1. CHECK OPERATING CONDITION OF VERTICAL MILLING MACHINE
2. CHECK DIVIDING HEAD FOR PROPER SETUP AND ALIGNMENT
3. CORRECT SETUP OF WORKPIECE AND TOOLING
4. ALL DIMENSIONS HELD TO SPECIFICATIONS AND TOLERANCE
5. OBSERVANCE OF ALL SAFETY REGULATIONS
6. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS

TASK SHEET IX-C-9(TS)

TASK: MILL 13/64" X 17/64" OBLONG SLOT

JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: VERTICAL MILLING MACHINE, DIVIDING HEAD WITH UNIVERSAL CHUCK, 3/16" END MILL, END MILL HOLDER, 6" RULE, MILL FILE, AND PART #6: WASHER "A" AS MACHINED IN PREVIOUS TASK

TASK BREAKDOWN:

<table>
<tr><th>STEPS</th><th>KEY POINTS</th></tr>
<tr><td>1. SET UP MACHINE</td><td>1. SET UP 3/16" END MILL HOLDER
2. INSTALL 3/16" END MILL
3. CHECK END MILL FOR RUNNING TRUE
4. SET SPINDLE SPEED</td></tr>
<tr><td>2. SET UP WORKPIECE

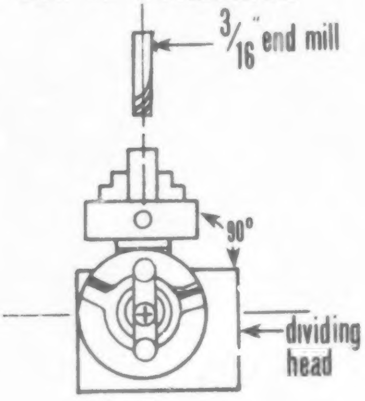
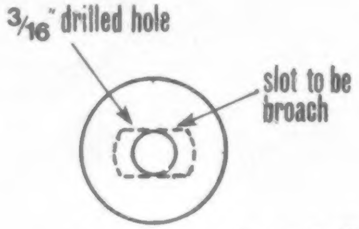


Fig. 1</td><td>1. MOUNT WORKPIECE IN UNIVERSAL CHUCK
NOTE: CLAMP ON EXCESS MATERIAL
2. TIGHTEN CHUCK
3. ROTATE DIVIDING HEAD 90°
NOTE: WORKPIECE WILL BE PERPENDICULAR TO TABLE. REFER TO FIG. #1
4. CHECK WORKPIECE ALIGNMENT
NOTE: USE DIAL INDICATOR TO INSURE WORKPIECE IS PERPENDICULAR TO TABLE</td></tr>
<tr><td>3. MACHINE SLOT



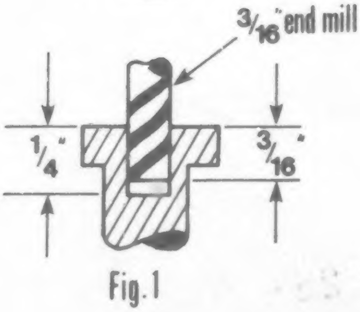


Fig. 1</td><td>1. LOCATE END MILL IN 13/64" HOLE
NOTE: TURN SPINDLE ON BEFORE END MILL ENTERS HOLE
2. RAISE TABLE UNTIL END MILL IS SLIGHTLY MORE THAN 1/16" DEEP
NOTE: 3/16" DEEP. SEE FIG. 2
3. MOVE LONGITUDINAL FEED UNTIL END MILL HAS MACHINED THE SLOT 17/64" LONG
NOTE: THIS WILL LEAVE ONLY THE FOUR CORNERS TO BE BROACHED OR FILED, WHICHEVER METHOD IS TO BE USED</td></tr>
</table>

STEPS	KEY POINTS
	CAUTION: TO ATTEMP TO BROACH THE SLOT WITHOUT MILLING THE SLOT FIRST WOULD RESULT IN BENDING THE WORKPIECE
	4. REMOVE WORKPIECE AND BURR
	5. INSPECT
	6. SECURE ALL TOOLING AND MACHINE
	7. ROUTE WORKPIECE BACK TO THE LATHE TO CUT OFF WASTE MATERIAL

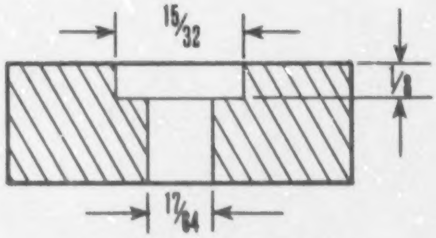
SKETCHES: DRAWING #3-H: SURFACE GAGE

REFERENCES: REF. #3, PP. 229-270
REF. #4, PP. 317-354
REF. #5, PP. 223-241

VI-C-5(J)

JOB SHEET
ON
DRILL PRESS

JOB: SURFACE GAGE



FIXTURE FOR BROACH

MATERIALS: 1/2" X 2" X 3" PLATE
NOTE: SIZE OF MATERIAL IS NOT CRITICAL, BUT 1/2" OR THICKER PLATE SHOULD BE USED, AND CAN BE SCRAP PLATE

TOOLS AND EQUIPMENT: DRILL PRESS, DRILL PRESS VISE, DRILL CHUCK AND KEY, 16/64" DRILL, 15/32" COUNTERBORE WITH 17/64" PILOT, DEPTH MICROMETER, AND MILL FILE

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 95-120; REF. #4, PP. 177-211; REF. #5, PP. 115-138
CHECK WITH INSTRUCTOR BEFORE USING DRILL PRESS AND UPON COMPLETION OF TASK

PROCEDURES AND/OR TASKS:	VI-A-1(TS)	CHECK DRILL PRESS FOR PROPER OPERATING CONDITION
	VI-A-1a(TS)	SET UP DRILL PRESS VISE AND WORKPIECE
	VI-C-4(TS)	MACHINE SPECIAL BROACH FIXTURE NOTE: REFER TO VI-C-4(TS) FOR PROCEDURE HOLD DIMENSIONS AS SPECIFIED IN ABOVE SKETCH ROUTE TO ARBOR PRESS

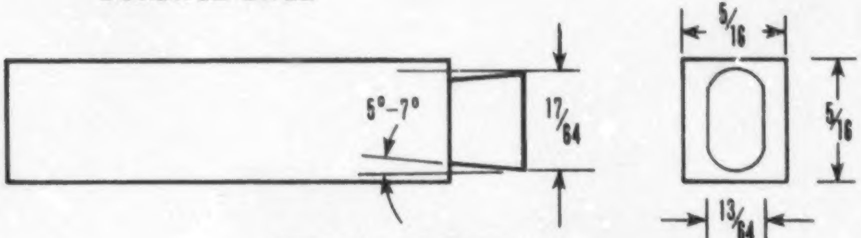
CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS

1. CHECK OPERATING CONDITION OF DRILL PRESS
2. SETUP OF VISE AND WORKPIECE
3. PROPER SELECTION AND INSPECTION OF TOOLS
4. ALL DIMENSIONS HELD TO SPECIFICATIONS
5. OBSERVANCE OF ALL SAFETY REGULATIONS

X-B-4(J)

JOB SHEET
ON
GRINDER

JOB:	SURFACE GAGE



SPECIAL BROACH

MATERIALS:	SPECIAL BROACH MADE FROM 5/16" X 5/16" H.S.S. LATHE TOOL	
TOOLS AND EQUIPMENT:	PEDESTAL OR BENCH GRINDER, 7/64" RADIUS GAGE, 0-1" MICROMETER, 6" RULE, AND HONE	
GENERAL INSTRUCTIONS:	BEFORE BEGINNING THIS JOB, STUDY THE ABOVE DRAWING AND READ REF. #3, PP. 121-125; REF. #4, PP. 143-147. IT IS RECOMMENDED THAT TASK X-B-3(TS) BE USED AS REFERENCE IF NEEDED ROUTE TO ARBOR PRESS	
PROCEDURES AND/OR TASKS:	X-B-3(TS)	CHECK GRINDER FOR PROPER OPERATING CONDITION
	X-B-3a(TS)	DRESS AND TRUE GRINDING WHEEL
	X-B-3b(TS)	GRIND SPECIAL BROACH
CHECK POINTS:	STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS.	

1. CHECK OPERATING CONDITION OF GRINDER
2. GRINDING WHEEL PROPERLY DRESSED
3. OBSERVANCE OF ALL SAFETY RULES

IV-C-7(J)

JOB SHEET
ON
BENCH

JOB: SURFACE GAGE

MATERIALS: PART #6: WASHER "A" AS PREVIOUSLY MACHINED

TOOLS AND EQUIPMENT: ARBOR PRESS, SPECIAL BROACH, BROACH FIXTURE, AND PATTERN FILE

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 223-225; REF. #4, PP. 25-29; REF. #5, PP. 76-77. CHECK WITH INSTRUCTOR BEFORE BROACHING WORKPIECE AND UPON COMPLETION OF TASKS. REFER TO IV-C-4a(TS) IF NECESSARY

PROCEDURES AND/OR TASKS:

IV-C-7(TS)	SET UP ARBOR PRESS
IV-C-7a(TS)	BROACH SLOT
	HOLD FOR ASSEMBLY

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS

1. PROPER SETUP OF ARBOR PRESS AND BROACH
2. PROPER INSTALLATION OF WORKPIECE AND FIXTURE
3. OBSERVANCE OF ALL SAFETY REGULATIONS

VII-C-11(J)

JOB SHEET
ON
ENGINE LATHE

JOB: SURFACE GAGE

MATERIAL: PART #2: MARKER - 7/16" SQUARE X 1" TOOL STEEL
NOTE: THIS ALLOWS FOR CHUCKING

TOOLS AND EQUIPMENT: ENGINE LATHE, INDEPENDENT CHUCK, DIAL INDICATOR, FACING TOOL, DRILL CHUCK AND KEY, 9/64" DRILL, 82° COUNTERSINK, CUT-OFF TOOL, MILL FILE, AND #4 CENTER-DRILL

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 135-184; REF. #4, PP. 217-282; REF. 35, PP. 141-182

PROCEDURES AND/OR TASKS:

VII-A-1(TS)	CHECK ENGINE LATHE FOR PROPER OPERATING CONDITION
*VII-C-11(TS)	MACHINE PART #2: MARKER
	ROUTE TO HORIZONTAL MILLING MACHINE

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS

1. OPERATING CONDITION OF ENGINE LATHE
2. CORRECT SETUP OF TOOLING AND WORKPIECE
3. ALL DIMENSIONS HELD TO SPECIFICATIONS
4. OBSERVANCE OF ALL SAFE WORKING HABITS
5. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR MACHINE TOOLS, EQUIPMENT, SUPPLIES, AND STANDARDS

TASK SHEET

VII-C-11(TS)

TASK: MACHINE PART #2: MARKER

JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: ENGINE LATHE, INDEPENDENT CHUCK, DIAL INDICATOR, FACING TOOL, DRILL CHUCK AND KEY, 9/64 DRILL, #4 CENTERDRILL, 82° COUNTERSINK, CUT-OFF TOOL, MILL FILE AND MATERIAL FOR PART #2: 7/16 SQUARE TOOL STEEL X 1" LONG

TASK BREAKDOWN:

STEPS	KEY POINTS
1. CHUCK WORKPIECE	1. SET UP INDEPENDENT CHUCK 2. MOUNT WORKPIECE IN CHUCK NOTE: EXTEND WORKPIECE 3/8" FROM CHUCK JAWS 3. TRUE WORKPIECE NOTE: WHEN INDICATING SQUARE MATERIAL, INDICATE ON THE CORNERS CAREFULLY CAUTION: DO NOT USE DIAL INDICATOR UNTIL WORKPIECE IS REASONABLY TRUE TO AVOID POSSIBLE DAMAGE TO INDICATOR STEM
2. FACE AND CENTERDRILL	1. SET UP FACING TOOL 2. FACE FOR CLEANUP ONLY 3. SET UP DRILL CHUCK AND #4 CENTERDRILL 4. CENTERDRILL FOR PILOT HOLE ONLY 5. REMOVE CENTERDRILL
3. DRILL AND COUNTERSINK HOLE	1. SET UP 9/64" DRILL 2. SET SPINDLE SPEED 3. DRILL TO DEPTH NOTE: HOLD 1/4" DEPTH 4. REMOVE DRILL 5. SET UP 82° COUNTERSINK 6. COUNTERSINK HOLE NOTE: HOLD 9/32° DIAMETER TO FIT 6-32 N.C. FLAT HEAD MACHINE SCREW 7. REMOVE COUNTERSINK

STEPS	KEY POINTS
4. CUT OFF WORKPIECE	1. SET UP CUT-OFF TOOL 2. SET SPINDLE SPEED NOTE: SPEED SHOULD BE VERY SLOW WHEN CUTTING OFF SQUARE MATERIAL 3. POSITION CUT-OFF TOOL NOTE: HOLD 1/16" FROM END. SEE FIG. 1 4. LOCK CARRIAGE 5. CUT OFF WORKPIECE TO 1/16" SPECIFIED SIZE 6. BURR AND INSPECT 7. SECURE MACHINE AND TOOLS ROUTE TO THE HORIZONTAL MILLING MACHINE

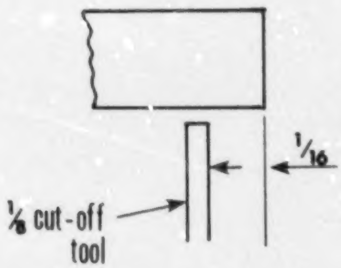


Fig. 1

SKETCHES: DRAWING #3-H: SURFACE GAGE

REFERENCES: REF. #3, PP. 135-184
REF. #4, PP. 217-282
REF. #5, PP. 141-182

IX-C-10(J)

JOB SHEET
ON ________
HORIZONTAL MILLING MACHINE

JOB:	SURFACE GAGE	
MATERIAL:	PART #2: MARKER AS MACHINED ON THE ENGINE LATHE IN PREVIOUS TASK	
TOOLS AND EQUIPMENT:	HORIZONTAL MILLING MACHINE, ARBOR AND SPACING COLLARS, MILL VISE, 3/64" PARALLEL, 60° ANGLE CUTTER AND MILL FILE	
GENERAL INSTRUCTIONS:	BEFORE BEGINNING THIS JOB READ REF. #3, PP. 229-270; REF. #4, PP. 317-354; REF. #5, PP. 223-241. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE AND UPON COMPLETION OF TASKS	
PROCEDURES AND/OR TASKS:	IX-C-1(TS)	CHECK MILLING MACHINE FOR PROPER OPERATING CONDITION
	*IX-C-10(TS)	MILL 1/32" X 1/16" DOUBLE BEVELS ROUTE TO HEAT TREAT

CHECK WITH INSTRUCTOR FOR PROCEDURE TO BE USED IN HEAT TREATING WORKPIECE

CAUTION: DO NOT BURN OFF EDGES BY OVERHEATING

NOTE: HAND POLISH WORKPIECE TO REMOVE OXIDE SCALE

HOLD FOR ASSEMBLY

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS

1. CHECK OPERATING CONDITION OF HORIZONTAL MILLING MACHINE
2. CHECK VISE FOR ALIGNMENT
3. CHECK WORKPIECE FOR CORRECT SETUP
4. ALL DIMENSIONS HELD TO SPECIFICATIONS
5. OBSERVANCE OF ALL SAFETY REGULATIONS
6. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR MACHINE TOOLS, EQUIPMENT, AND STANDARDS

TASK SHEET

TASK: MILL 1/32" X 1/16" DOUBLE BEVELS

JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: HORIZONTAL MILLING MACHINE, ARBOR AND SPACING COLLARS, MILL VISE, 3/64" PARALLELS, 60° ANGLE CUTTER, AND MILL FILE

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP MILL VISE	1. INSTALL VISE ON TABLE NOTE: VISE JAWS WILL BE PARALLEL TO MILLING CUTTER 2. ALIGN VISE JAWS NOTE: USE DIAL INDICATOR TO INDICATE VISE TRUE
2. SET UP MILLING MACHINE	1. INSTALL 60° ANGLE CUTTER NOTE: 60° IS THE INCLUDED ANGLE OF THE CUTTER 2. POSITION CUTTER IN CENTER OF ARBOR 3. SET SPINDLE SPEED AND FEED
3. SET UP WORKPIECE	1. WIPE INSIDE OF VISE JAWS CLEAN 2. PLACE WORKPIECE IN VISE NOTE: SET WORKPIECE ON A PARALLEL BAR IF AVAILABLE. PARALLEL SHOULD BE LESS THAN 1/16" THICKNESS NOTE: WORKPIECE WILL EXTEND ABOVE VISE JAWS 1/8" 3. TRUE WORKPIECE WITH DIAL INDICATOR NOTE: WORKPIECE MUST BE LEVEL AND PARALLEL TO MILLING CUTTER
4. BEVEL FIRST EDGE	1. LOCATE CUTTER OVER WORKPIECE 2. RAISE TABLE UNTIL CUTTER TOUCHES WORKPIECE NOTE: HAVE SPINDLE TURNED ON 3. SET THE VERTICAL FEED DIAL ON "0" 4. LOWER TABLE TO CLEAR CUTTER 5. POSITION CUTTER FOR FIRST BEVEL CUT NOTE: CENTER LINE OF CUTTER WILL BE SLIGHTLY AWAY FROM OUTSIDE EDGE OF WORKPIECE

STEPS | KEY POINTS

NOTE: ABOUT .005" TO .010"
REFER TO FIG. #1

6. RAISE TABLE .0625"
NOTE: THIS WILL BE THE FULL DEPTH OF BEVEL CUT
CAUTION: REDUCE DEPTH OF CUT SHOULD WORK CHATTER
7. MILL BEVELED EDGE
NOTE: HOLD TO 1/16" DEPTH X 1/32" WIDTH OR CENTER LINE OF WORKPIECE
8. MOVE LONGITUDINAL FEED TO CLEAR WORKPIECE
NOTE: HOLD DEPTH OF CUTTER
9. MOVE TABLE OUT .070"
NOTE: THIS WILL POSITION CUTTER ON THE INSIDE EDGE OF WORKPIECE. REFER TO FIG. 2
10. MILL SECOND BEVEL AS PER FIRST
NOTE: HOLD CENTERLINE OF WORKPIECE AND 1/16" DEPTH
NOTE: BEVEL SHOULD INTERSECT IN THE CENTER OF WORKPIECE
11. CLEAR CUTTER FROM WORKPIECE
NOTE: DO NOT CHANGE CROSSFEED OR VERTICAL SETTING
12. BURR EDGES LIGHTLY
13. INSPECT BEVELED EDGE
14. REMOVE FROM VISE

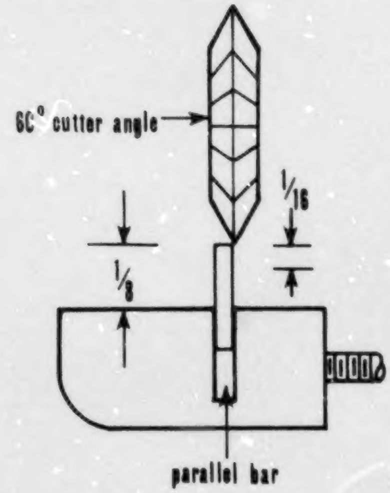


Fig. 1

5. BEVEL SECOND EDGE

1. CLEAN CHIPS FROM VISE AND PARALLEL
2. POSITION WORKPIECE IN VISE AS PER STEP #2
NOTE: TURN WORKPIECE 90° SO BEVELED EDGE MACHINED IN STEP #4 WILL BE IN A VERTICAL POSITION
3. TRUE EDGE AS PER STEP #3
4. LOCATE ANGLE CUTTER WITH WORKPIECE AS PER STEP #4
NOTE: IF CROSSFEED OR VERTICAL FEED HAS NOT BEEN CHANGED, WORKPIECE WILL BE IN POSITION TO MILL FIRST BEVEL ON THE SECOND EDGE
NOTE: CUTTERWILL BE POSITIONED TO CUT INSIDE BEVEL AS PER STEP #5. SEE FIG. 2

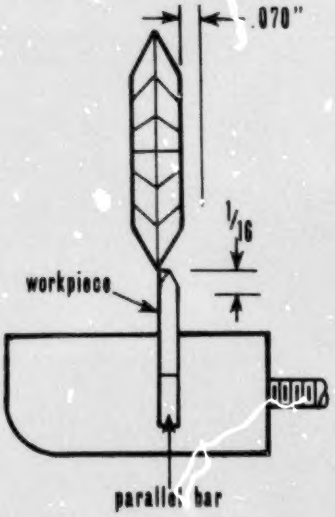
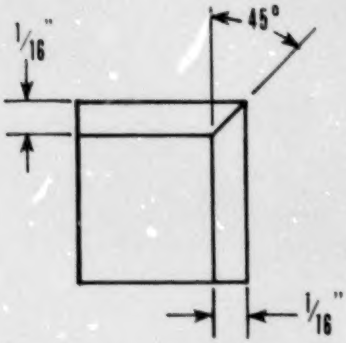
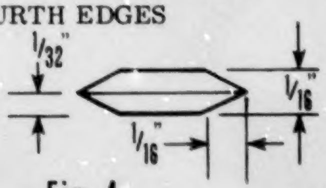


Fig. 2

STEPS	KEY POINTS
 Fig. 3	5. MILL FIRST BEVEL NOTE: HOLD 1/16" DEPTH AND CENTER OF WORKPIECE 1/32" FROM EDGE AS PER STEPS #4 AND #5 6. REPOSITION WORKPIECE BY MOVING TABLE CROSSFEED IN .070" NOTE: CUTTER WILL NOW BE POSITIONED ON THE OUTSIDE EDGE OF WORKPIECE AS PER STEP #4, FIG. 1 7. MILL SECOND BEVEL NOTE: HOLD 1/16" DEPTH AND CENTER OF WORKPIECE 8. BURR AND INSPECT WORKPIECE NOTE: THE TWO ADJACENT BEVELS SHOULD INTERSECT AND FORM A 45° LINE TOWARD THE CORNER. SEE FIG. 3 NOTE: INSPECT BOTH SIDES
6. BEVEL THIRD AND FOURTH EDGES  Fig. 4	1. AS PER STEPS #3, #4, AND #5 NOTE: HOLD 7/16" X 7/16" SQUARE WITH 1/16" X 1/32" DOUBLE BEVELED EDGES ON ALL FOUR SIDES AS SPECIFIED 2. BURR AND INSPECT 3. SECURE TOOLS AND MACHINE 4. ROUTE WORKPIECE TO HEAT TREAT

SKETCHES: DRAWING #3-H: SURFACE GAGE

REFERENCES:
REF. #3, PP. 229-270
REF. #4, PP. 317-354
REF. #5, PP. 223-241

VII-C-12(J)

JOB SHEET
ON
ENGINE LATHE

JOB: SURFACE GAGE

MATERIALS: PART #4: POST - 5/16" X 7 3/8" DRILL ROD

TOOLS AND EQUIPMENT: ENGINE LATHE, COLLET ATTACHMENT, 5/16" COLLET, FACING TOOLS, DRILL CHUCK AND KEY, #1 CENTERDRILL, #36 DRILL, 6-32 N. C. TAPER TAP, 6-32 N. C. BOTTOM TAP, TAP WRENCH, 1/16" RADIUS GROOVING TOOL, 5/16" RADIUS TURNING TOOL, 6" RULE, LIVE CENTER, MILL FILE, AND 5/16" RADIUS GAGE

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 135-184; REF. #4, PP. 217-282; REF. #5, PP. 141-182. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE

PROCEDURES AND/OR TASKS:

VII-A-1(TS) CHECK ENGINE LATHE FOR PROPER OPERATING CONDITION

*VII-C-12(TS) MACHINE SURFACE GAGE POST
HOLD FOR ASSEMBLY

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS

1. CHECK MACHINE FOR PROPER OPERATING CONDITION
2. CHECK FOR PROPER SETUP OF MACHINE AND TOOLING
3. ALL DIMENSIONS HELD TO SPECIFICATIONS
4. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS
5. OBSERVANCE OF ALL SAFETY REGULATIONS

TASK: MACHINE SURFACE GAGE POST

JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: ENGINE LATHE, COLLET ATTACHMENT, 5/16" COLLET, 1/16" RADIUS GROOVING TOOL, 5/16" RADIUS FORMING TOOL, 6" RULE, MILL FILE, PART #4: MATERIAL: 5/16" X 7 3/8" DRILL ROD, FACING TOOL, DRILL CHUCK, #1 CENTER-DRILL, #36 DRILL, 6-32 N.C. TAPER AND BOTTOM TAP, TAP WRENCH, LIVE CENTER, AND 5/16" RADIUS GAGE

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP WORKPIECE	1. INSTALL 5/16" COLLET IN COLLET ATTACHMENTS 2. MOUNT WORKPIECE IN COLLET NOTE: ALLOW WORKPIECE TO EXTEND FROM COLLET 1/2" 3. CHECK WORKPIECE FOR RUNNING TRUE
2. FACE AND CENTERDRILL HOLE	1. SET UP FACING TOOL 2. FACE END FOR CLEANUP ONLY 3. SET UP DRILL CHUCK WITH #1 CENTER-DRILL 4. CENTERDRILL FOR PILOT ONLY 5. REMOVE CENTER DRILL
3. DRILL AND TAP HOLE	1. SET UP #36 DRILL 2. DRILL HOLE 5/16" DEEP 3. REMOVE DRILL CHUCK AND DRILL 4. SET UP LIVE CENTER IN TAILSTOCK 5. SET UP 6-32 N.C. TAPER TAP AND WRENCH IN DRILLED HOLE 6. SLIDE TAILSTOCK AND CENTER UP TO TAP NOTE: CENTER WILL PROVIDE SUPPORT AND ALIGNMENT. REFER TO FIGURE 1 7. TAP HOLE 6-32 N.C. 1/4" DEEP NOTE: USE BOTTOM TAP AFTER TAPER TAP TO PROVIDE FULL THREAD 8. REMOVE TAP AND TAP WRENCH 9. BURR AND INSPECT THREAD

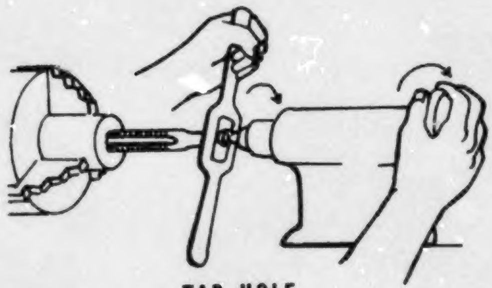
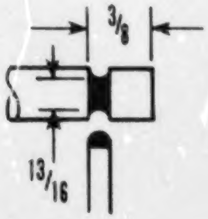
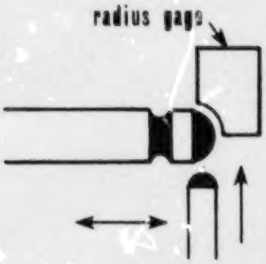


Fig. 1 TAP HOLE

STEPS	KEY POINTS
	NOTE: CHECK WITH 6-32 N.C. SCREW 10. REMOVE WORKPIECE
4. TURN 5/16" DIAMETER BALL	1. MOUNT WORKPIECE IN COLLET ON OPPOSITE END NOTE: ALLOW WORKPIECE TO EXTEND OUT 3/4" 2. CHECK FOR RUNNING TRUE
5. SET UP GROOVING TOOL  Fig. 2	1. MOUNT TOOL IN TOOL POST NOTE: HOLD SAME POSITION AS CUT-OFF TOOL WITH TOOL ON CENTER WITH WORKPIECE 2. POSITION TOOL 3/8" FROM END OF WORKPIECE TO INSIDE EDGE OF TOOL. REFER TO FIGURE 2
6. TURN BALL RELIEF	1. SET SPINDLE SPEED 2. FEED GROOVING TOOL INTO WORKPIECE SLOWLY NOTE: HOLD 3/16" DIAMETER X 3/8" LENGTH NOTE: DIAMETER IS NOT CRITICAL DIMENSION. REFER TO FIGURE 2
7. TURN 5/16" SPHERE  Fig. 3	1. REMOVE GROOVING TOOL 2. SET UP 5/16" RADIUS FORMING TOOL 3. TURN BALL NOTE: MOVE CARRIAGE MANUALLY WITH THE LEFT HAND WHILE FEEDING TOOL OUT OR IN WITH THE CROSSFEED HANDWHEEL SIMULTANEOUSLY TO FORM BALL. REFER TO FIGURE 3 4. CHECK WITH RADIUS GAGE. REFER TO FIGURE 3 5. FILE TO OBTAIN SMOOTH SPHERICAL FINISH 6. POLISH BALL 7. INSPECT AND REMOVE NOTE: HOLD 7 5/16" OVERALL LENGTH HOLD FOR ASSEMBLY

STEPS		KEY POINTS
SKETCHES:	DRAWING #3-J: SURFACE GAGE	
REFERENCES:	REF. #3, PP. 135-184 REF. #4, PP. 217-282 REF. #5, PP. 141-182	

VII-C-13(J)

JOB SHEET
ON
ENGINE LATHE

JOB: SURFACE GAGE

MATERIALS: PART #3: SCRIBE - 1/8" X 8" DRILL ROD

TOOLS AND EQUIPMENT: ENGINE LATHE, COLLET ATTACHMENT, 1/8" COLLET, MILL FILE, 6" RULE, AND 240 GRIT EMERY

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #3, PP. 229-270; REF. #4, PP. 217-282; REF. #5, PP. 141-182. CHECK WITH INSTRUCTOR BEFORE OPERATING MACHINE AND UPON COMPLETION OF TASK

PROCEDURES AND/OR TASKS:

VII-A-1(TS)	CHECK ENGINE LATHE FOR PROPER OPERATING CONDITION
*VII-C-13(TS)	MACHINE PART #3: SCRIBER ROUTE TO BENCH

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS.

1. CHECK MACHINE FOR PROPER OPERATING CONDITION
2. CHECK FOR PROPER SETUP OF WORKPIECE AND TOOLING
3. ALL DIMENSIONS HELD TO SPECIFICATIONS
4. OBSERVANCE OF ALL SAFETY REGULATIONS
5. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS

TASK SHEET

VII-C-13(TS)

TASK: MACHINE PART #3: SCRIBER

JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: ENGINE LATHE, COLLET ATTACHMENT, 1/8" COLLET, MILL FILE, FILE CARD, 6" RULE, 240 GRIT EMERY, AND PART #3: 1/8" X 8" DRILL ROD

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP WORKPIECE	1. INSTALL COLLET ATTACHMENT AND 1/8" COLLET 2. MOUNT WORKPIECE IN COLLET NOTE: WORKPIECE TO EXTEND OUT 1 1/4" FROM COLLET
2. FILE FIRST END	1. FILE FIRST END TO A POINT NOTE: HOLD 1" LENGTH NOTE: MOVE FILE ACROSS AT ANGLE APPLYING LIGHT PRESSURE CAUTION: HOLD FILE HANDLE IN LEFT HAND TO PREVENT POSSIBLE INJURY 2. POLISH WITH 240 GRIT EMERY
3. FILE SECOND END	1. FOLLOW SAME PROCEDURE AS IN STEP #1 AND #2 2. REMOVE WORKPIECE AND INSPECT ROUTE TO WORK BENCH

SKETCHES: DRAWING #3-J: SURFACE GAGE

REFERENCES:
REF. #3, PP. 229-270
REF. #4, PP. 217-282
REF. #5, PP. 141-182

IV-C-8 (J)

JOB SHEET
ON
BENCH

JOB: SURFACE GAGE

MATERIALS: PART #3: SCRIBER - AS MACHINED IN PREVIOUS TASK

TOOLS AND EQUIPMENT: BENCH VISE, VISE JAW PROTECTIVE CAPS, SOFT FACE HAMMER, 240 GRIT EMERY. TONGS, 6" RULE, 1/2" ROUND SCRAP PIECE, QUENCHING VAT, AND BUNSEN BURNER

GENERAL INSTRUCTIONS: BEFORE BEGINNING THIS JOB READ REF. #2, PP. 342-344; REF. #3, PP. 377-385. CHECK WITH INSTRUCTOR PRIOR TO FORMING AND HEAT TREATING SCRIBE

PROCEDURES AND/OR TASKS:

*IV-C-8(TS)	FORM 1/2" RADIUS SCRIBER POINT
*IV-C-8a(TS)	HEAT TREAT AND POLISH SCRIBER POINTS
	HOLD FOR ASSEMBLY

CHECK POINTS: STUDENT TO CONFER WITH INSTRUCTOR AT THESE INDICATED POINTS BEFORE PROCEEDING WITH TASKS.

1. CHECK THE TOOLS AND EQUIPMENT FOR SAFE USE
2. CHECK FOR PROPER SETUP OF WORKPIECE
3. CHECK WORKPIECE FOR PROPER HARDENING AND TEMPERING TEMPERATURE
4. CRAFTSMANLIKE PERFORMANCE AND APPRECIATION FOR TOOLS, EQUIPMENT, AND STANDARDS

TASK SHEET IV-C-8 (TS)

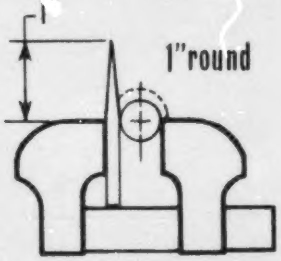
TASK: FORM 1/2" RADIUS SCRIBER POINT

JOB: SURFACE GAGE

TRADE: MACHINIST

TOOLS AND MATERIALS: BENCH VISE, SOFT FACE HAMMER, VISE JAW PROTECTIVE CAPS, 6" RULE, ONE PIECE OF 1" ROUND. (NOTE: THIS MAY BE A PIECE OF SCRAP), AND PART #3: SCRIBER

TASK BREAKDOWN:

STEPS	KEY POINTS
1. SET UP WORKPIECE  Fig. 1	1. CLAMP WORKPIECE IN VISE NOTE: VISE JAWS SHOULD HAVE PROTECTIVE CAPS TO PREVENT SCORING WORKPIECE 2. PLACE 1" ROUND BETWEEN WORKPIECE AND VISE JAW. REFER TO FIG. #1 NOTE: POSITION WORKPIECE AND 1" ROUND SO 1" LAYOUT MARK WILL BE ON CENTER LINE OF ROUND PIECE AND POSITIONED AT THE TOP OF VISE JAW 3. TIGHTEN VISE
2. FORM RADIUS	1. STRIKE WORKPIECE WITH SOFT FACE HAMMER NOTE: START NEAR THE LOWER PART OF THE MATERIAL 2. BEND WORKPIECE AROUND THE ROUND BAR UNTIL COMPLETE RADIUS HAS BEEN FORMED NOTE: SHOULD WORKPIECE CONTACT VISE JAW BEFORE RADIUS IS COMPLETE, REVOLVE WORKPIECE AROUND ROUND BAR TO CLEAR FINAL FORMING. REFER TO FIG. #1 3. ROUTE TO HEAT TREAT

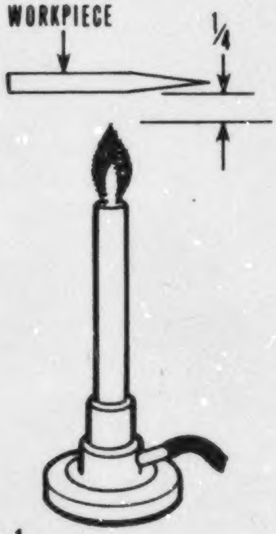
SKETCHES: DRAWING #3-J: SURFACE GAGE

REFERENCES: REF. #2, PP. 342-344
REF. #3, PP. 377-385

TASK SHEET IV-C-8a(TS)

TASK:	HEAT TREAT AND POLISH SCRIBER POINTS
JOB:	SURFACE GAGE
TRADE:	MACHINIST
TOOLS AND MATERIALS:	BUNSEN BURNER, QUENCHING VAT WITH OIL, TONGS, 240 GRIT EMERY, AND PART #3: SCRIBER POINTS AS MACHINED IN PREVIOUS TASKS NOTE: A SMALL OXYACETYLENE TORCH MAY BE USED INSTEAD OF THE BUNSEN BURNER

TASK BREAKDOWN:

STEPS	KEY POINTS
1. LIGHT BUNSEN BURNER	1. CHECK ALL GAS CONNECTIONS FOR LEAKS 2. LIGHT MATCH 3. CUT ON GAS AND LIGHT 4. ADJUST FLAME
2. HEAT TREAT POINTS A. HARDEN WORKPIECE  Fig.1 BUNSEN BURNER	1. HOLD WORKPIECE ABOUT 1/4" ABOVE FLAME REFER TO FIG. 1 CAUTION: DO NOT APPLY FLAME DIRECTLY TO POINT AS THE MATERIAL IS THIN AND WILL BURN OR DISTORT 2. CONTINUE TO HEAT WORKPIECE UNTIL POINT REACHES CHERRY RED OR ABOUT 1500° NOTE: MOVE WORKPIECE SLOWLY BACK AND FORTH ABOVE FLAME CAUTION: DO NOT ALLOW WORKPIECE TO OVERHEAT AS THIS WILL CAUSE AN OXIDIZING EFFECT ON THE MATERIAL 3. IMMERSE POINT QUICKLY IN VAT NOTE: POINT SHOULD BE STRAIGHT UP AND DOWN TO PREVENT WARPING OR DISTORTION 4. REPEAT SAME PROCEDURE ON OPPOSITE END 5. POLISH BOTH ENDS WITH 240 EMERY
B. TEMPER WORKPIECE	1. REHEAT WORKPIECE CAREFULLY TO PURPLE-BLUE 2. QUENCH IN VAT AS PER KEY POINT #3

STEPS	KEY POINTS
	NOTE: REPEAT SAME PROCEDURE FOR OPPOSITE END
3. POLISH WORKPIECE	1. POLISH WORKPIECE WITH 240 GRIT EMERY 2. REMOVE ALL OF THE OXIDE SCALE NOTE: IF CARE HAS BEEN TAKEN IN TEMPERING WORKPIECE, THERE SHOULD BE NO SCALE, AND THE WORKPIECE CAN BE LEFT A PURPLE-BLUE COLOR CAUTION: USE EXTREME CARE IN POLISHING THE POINT TO AVOID INJURY 3. INSPECT WORKPIECE 4. SECURE WORK AREA 5. HOLD FOR ASSEMBLY

SKETCHES: DRAWING #3-J: SURFACE GAGE

REFERENCES: REF. #2, PP. 349-350
REF. #3, PP. 377-385